Autonomous vehicle (AV) technology offers specific promises that no other technology has yet offered - the prospect of radically reducing road fatalities, a significant reduction in the number and severity of incidents, along with environmental and societal benefits. This Article takes an interdisciplinary approach to understand and create a basis for legal discussion for further development and offers tools for policymakers seeking concrete principles on which to define potential laws and regulations. In doing so, this Article comprehensively surveys the emerging federal and state statutory and legislative developments, reviews existing laws regarding AVs, and answers the question of whether these regulations are adequate or should be revised in light of the particular features of AV technology. This Article finds that there is still a significant aspect of AVs that have yet to be addressed in state regulations and that inconsistencies between them are significant. This

* Assistant Professor & Head of the IT Law Department at Ali Fuad Basgil School of Law, Ondokuz Mayis University. I would like to express my gratitude to Prof. Michael D. Green for his invaluable comments, which have made this work concise and well-organized. I would also like to thank the Ohio State Technology Law Journal executive board and staff members for their diligent efforts in preparing this note for publication. This Article is dedicated to my newborn twins, Ada and Balamir, who have created a beautiful new world within my world.
Article makes the case for federal regulatory and legislative action that would ensure safe and reliable testing and operation of AVs and harmonization among states in the future.

I. INTRODUCTION ................................................................. 318

II. SETTING THE SCENE: DISTINGUISHING AVs BASED ON THE DEGREE OF AUTONOMY ............................................. 324

III. DEFINITION OF AVs AND TECHNICAL TERMS ................ 325
A. The AV System ................................................................. 325
B. Operator ............................................................................. 330
C. Classification .................................................................... 333
D. Dynamic Driving Task ....................................................... 334
E. Operational Design Domain ............................................... 338
F. Minimal Risk Condition ...................................................... 339

IV. OPERATION AND TESTING REQUIREMENTS FOR AVs 341
A. Driver Requirements .......................................................... 341
B. Performance Requirements ................................................ 344
C. Compliance with Federal and State Law ............................... 345
D. System Safety .................................................................... 349
E. Validation Methods ............................................................ 352
F. New Standards for Cybersecurity in AVs ............................. 355
G. Data Sharing on Cybersecurity ............................................ 367
H. California’s Approach to Safety and Cybersecurity ............... 368

V. A HUMAN DRIVER AND LICENSING REQUIREMENTS FOR AVs ........................................ 370

VI. TELEOPERATION SYSTEM ............................................ 372

VII. AUTONOMOUS VEHICLE NETWORKS ................................. 374
VIII. STATUTORY DUTIES RELATED TO POST–CRASH, TRANSPORTING CHILDREN, SEAT BELTS IN THE ERA OF AVs

A. Post–Crash Duties

B. Duties on Persons Transporting a Child

C. Duties to Use Seat Belts

IX. DESIGN REQUIREMENTS RELATED TO DISENGAGEMENT, HUMAN MACHINE INTERFACE, DATA RECORDERS, SOFTWARE UPDATES

A. Disengagement System and Human Machine Interface

B. Collecting Data

C. Sharing Data

X. DISCLOSURE, WARNING, AND MISREPRESENTATION REQUIREMENTS

A. Disclosure

B. Warning Requirements

C. Misrepresentation Requirements

XI. PLATOON TECHNOLOGY

XII. THE SUPREMACY OF FEDERAL LEGISLATION AND REGULATION

XIII. CONCLUDING REMARKS
I. INTRODUCTION

Autonomous vehicles (AVs) are here. They transport people in cities as a ride hailing service\(^1\) and shuttle service,\(^2\) deliver meals to low-income residents\(^3\) and medical supplies to hospitals,\(^4\) carry ore in mining operations,\(^5\) and are ready to plow on a farm.\(^6\) AV technology does not come alone. It brings revolutionary benefits to society, the economy, and the environment. This technology will reduce the number of traffic accidents, offer mobility for the elderly and disabled, increase road capacity, save fuel, and lower emissions.\(^7\) Due to these expected benefits, research predicts that AVs will save the US economy $1.3

---


\(^5\) Global Autonomous Mining Truck Population Tops 1,000, GlobalData, https://www.globaldata.com/data-insights/mining/global-autonomous-mining-truck-population-tops-1000/ [https://perma.cc/2A5G-2U77] (stating that the number of autonomous haul trucks increased from 769 to 1,068 in the world between May 2021 and May 2022, constituting an increase of 39%).

\(^6\) Scott McFetridge, *Self-driving Vehicles are Coming to the Farm as John Deere Plans to Roll out Driverless Tractors*, USA Today (March 17, 2022, 7:01 AM), https://www.usatoday.com/story/money/2022/03/17/john-deere-autonomous-tractor-farming/7066741001/ [https://perma.cc/7EU6-C2CF].

trillion per year.\textsuperscript{8} Plus, according to recent research by Mckinsey & Company, AV technology could lead to establishing a new market valuing $300 billion to $400 billion by 2035.\textsuperscript{9}

In order to keep pace with these developments, federal and state regulators took many regulatory actions. On March 30, 2022, the National Highway Traffic Safety Administration (NHTSA) declared its final rules for AVs.\textsuperscript{10} This regulation has been long awaited by AV developers who complain that federal motor vehicle safety standards (FMVSSs)\textsuperscript{11} constitute regulatory barriers to the development of AV technology.\textsuperscript{12} Thus, the NHTSA’s final rule became the first federal regulation for AV technology in the U.S. and is recorded in U.S. legal history.

This regulation, however, does not fully regulate all aspects of AV technology. The NHTSA changes the occupant protection FMVSSs to pave the way for AVs that do not have the traditional manual controls designed for human drivers.\textsuperscript{13} These standards are enacted for conventional motor vehicles and include terms such as “driver’s seat” and “steering wheel,” which do not fully apply to AVs that lack a steering wheel.\textsuperscript{14} The NHTSA clarified existing terminology and avoided unnecessary terminology to end uncertainties about how these standards apply to AVs.\textsuperscript{15}

\textsuperscript{8} RAVI SHANKER ET AL., MORGAN STANLEY, AUTONOMOUS CARS: SELF-DRIVING THE NEW AUTO INDUSTRY PARADIGM 48 (2013).
\textsuperscript{11} FMVSSs are safety standards that provide minimum performance requirements for new motor vehicles and for certain items of motor vehicle equipment. Manufacturers must self-certify that their vehicles conform with applicable FMVSS. U.S. DEP’T OF TRANSP. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., NEW MANUFACTURERS HandArticle: REQUIREMENTS FOR MANUFACTURERS OF MOTOR VEHICLES AND MOTOR VEHICLE EQUIPMENT 23 (2022), https://vpic.nhtsa.dot.gov/ManufacturerHandbook.pdf.
\textsuperscript{13} NHTSA 2022, supra note 10, at 18560. The most important change with this regulation is to make appropriate amendments to FMVSS No. 208, Occupant crash protection which references several terms that distinguishes a “driver’s” position from a front “passenger’s” seating position. \textit{Id.} at 18574.
\textsuperscript{14} \textit{Id.} at 18560.
\textsuperscript{15} \textit{Id.}. 
This is not to say that there is no federal guidance on other significant aspects of AV technology. Before the NHTSA's new regulation, The U.S. Department of Transportation (the U.S. DoT) announced four policies (the Guidance), which are not binding laws but instead guidance that may be voluntarily adopted by States and AV developers.\(^{16}\) This is because the U.S. DoT itself explicitly states that it is not intended for states or manufacturers to adopt them as legal requirements.\(^{17}\) The four policies published by the U.S. DoT include much important voluntary guidance for states and entities that desire to test or operate AVs, especially the design aspects of AVs, and may influence future regulation or legislation.\(^{18}\)

At the state level, with the proliferation of AVs, state governments have moved rapidly to establish a regulatory regime for AVs. Nevada was the first state to pass legislation authorizing AVs in 2011.\(^{19}\) Since then, twenty-eight other states and the District of Columbia have passed legislation related to AVs.\(^{20}\) Also, governors in eleven states have issued executive orders on the issue.\(^{21}\) It is noteworthy that, whereas some states have opened full space for AVs to operate, others have merely expressed interest in AVs. Holding an intermediate position, others have permitted only the testing of AVs.

States have traditionally had the duty to address traffic safety.\(^{22}\) The advent of AVs will not reduce the states' authority in the area of

---

\(^{16}\) All four policies are assessed together in this section without excluding any of them and referred to as "the Guidance." If, however, there is a significant difference on any subject between these policies, this Article will point out.


\(^{18}\) See U.S. DEP’T TRANSP., AUTOMATED DRIVING SYSTEMS 2.0: A VISION FOR SAFETY 2 (2017) https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/13069a--ads2.0_090617_v9a_tag.pdf [hereinafter NHTSA 2017] (emphasizing the voluntary nature of the Guidance that has no compliance requirement or enforcement mechanism); NHTSA 2016, supra note 17, at 11 (“This guidance is not mandatory. NHTSA may consider, in the future, proposing to make some elements of this Guidance mandatory and binding through future regulatory actions.”).


\(^{20}\) Id.

\(^{21}\) Id.

traffic safety, which includes (i) licensing human drivers; (ii) registering and inspecting motor vehicles; (iii) enacting traffic laws and regulations; (iii) conducting safety inspections; and (iv) regulating motor vehicle insurance and liability. These rules were enacted at a time when only human drivers were recognized as entities that could control a motor vehicle, and this is reflected in current practice. However, as we enter the era of AVs, states should consider modifying these regulations because human drivers will soon be replaced with AV technology. This era will also challenge the traditional allocation between state and federal law. For example, the U.S. DoT’s exercise of its authority could encompass tasks similar to “licensing” of a non-human driver—with hardware and software performing part or all of the driving task—as AV technology executes more and more “driving” tasks. Optimal and fair allocation of authority between federal and state powers, therefore, becomes urgent in the era of AVs.

Another risk is the current patchwork of state laws that could slow the progress of AV deployment. The U.S. DoT has expressed a desire to minimize the impact of inconsistent laws and regulations among the fifty states since this could impede the roll-out of AVs. The U.S. DoT does not dictate uniform or identical laws and regulations across all states but merely suggests the requisite consistency of laws and policies. However, the Department does not explain how states should approach regulatory consistency. Although the Guidance suggests that states look to the U.S. DoT alone to regulate “the performance” of AV technology and vehicles—to prevent conflicts between federal and state laws—it does not clarify what “performance” of AV technology means for state regulatory efforts. For example, minimal risk condition is defined by most states even though


24 NHTSA 2016, supra note 17, at 38.

25 NHTSA 2018, supra note 23, at v; NHTSA 2016, supra note 17, at 37. The U.S. DoT reckons that a manufacturer should focus on designing a single AV fleet instead of 50 different designs to satisfy the requirements of each state. Id. at 7.

26 NHTSA 2018, supra note 23, at ix; NHTSA 2017, supra note 18, at 18; NHTSA 2016, supra note 17, at 39.

27 NHTSA 2017, supra note 18, at 18; NHTSA 2016, supra note 17, at 37.
satisfying the definition of minimal risk condition falls within the performance of AV technology. Driver requirements for AVs, on the other hand, are not related to performance and states maintain their authority to regulate it.

The U.S. DoT’s fears of regulatory confusion appear warranted. Some states have already regulated AVs without waiting for federal regulation, and, not surprisingly, some of these regulations are inconsistent across states. Many states established commissions to study AVs, drawing members from a wide swath of society.28 These commissions have been assigned the task of proposing recommendations for future legislation covering the use of AVs.29 In so

---


29 WASH. REV. CODE § 47.01.510, (3)(b) (2018); N.J. AJR 164, 1(a) (2018) (assigning the Task Force a duty to recommend laws, rules, and regulations); The Delaware Executive Order, supra note 28, at (5); The Idaho Executive Order, supra note 28, at (6)(c); The Maine Executive Order, supra note 28; The Massachusetts Executive Order, supra note 28, section 1 (assigning AV Working Group a duty to work with the Legislature on any proposed legislation, propose changes to statutes or regulations, if necessary, to foster innovation on highly automated vehicles); The Minnesota Executive Order, supra note 28,
doing, they have touched upon issues related to licensing and registration, law enforcement and accident reporting, cybersecurity, insurance and liability, and the like. They have studied the potential long-term effects of using AVs. However, some have sought to regulate all aspects of AV technology, including performance aspects of AV technology that the U.S. DoT has claimed exclusive responsibility for. The Guidance’s unclear suggestions and its voluntary nature have played a part in this inconsistent regulation of AVs by states. As stated above, the Guidance is not mandatory or legally binding, which undermines its salience. The NHTSA’s new regulation does not promise to resolve this conflict because of its narrow scope.  

States may also be involved in a “race to the bottom” to attract AV developers to invest locally, to signal technological leadership, or to encourage technological innovation.  

This Article examines the NHTSA’s new regulation, the Guidance, state regulations, executive orders, and administrative guidelines. Any key differences between federal regulation, the Guidance, and state regulations will be detailed. This Article especially takes a critical approach toward federal regulation, the Guidance, and state regulations, and proposes many specific solutions. Specifically, this Article is dedicated to identifying inconsistencies and problematic provisions in state regulations. Most of the terms used in state regulations are strikingly similar, yet also contain significant differences that may hamper innovation. Further, what legislation, if any, might address the legal problems that AVs will pose in the future will be also examined. This Article will suggest the optimal regulation for federal and state regulators who have not attempted to regulate AV technology yet.

This Article will start with classifying AVs based on the SAE J3016 standard to clarify the scope of this work in Part II. In Part III,
this Article first will look at inconsistencies in definition of AVs and technical terms and their possible implications for the AV industry. Next, Part IV will analyze the current operation and testing requirements for AVs. Part V will then analyze current human driver and licensing requirements designed for conventional vehicles but will not be needed in the era of AVs. Part VI will then discuss a new technology that may ensure a safe transition period and is already regulated by some states, which is teleoperation. In Part VII, this Article will explain and discuss autonomous vehicle networks in state regulations, which are the future business model of AV developers. Part VIII will then examine the regulation related to post-crash, transporting children, and seat belts for AV technology. Part IX will continue with state regulations that impose requirements related to design, namely disengagement system, human machine interface and data recorders. Part X will critically assess disclosure, warning, and misrepresentation requirements. Part XI will describe connected vehicle technology and how this technology is subject to regulations at state level. Part XII will investigate preemption of positive enactments and discuss its possible implications in the future. Part XIII, the conclusion, will summarize the findings and provide a reasonable path for state and federal policymakers.

II. SETTING THE SCENE: DISTINGUISHING AVs BASED ON THE DEGREE OF AUTONOMY

When we refer to AVs, we do not simply assume an AV that travels anywhere without any operational limitation. That kind of AV, in fact, has not been designed yet. Because of many technical challenges in front of AVs that could operate without any operational limitation, the industry has developed standards for classifying existing AVs. The most cited and common standard in the AV industry is the SAE J3016 standard.\(^32\) This Article also adopts the levels of AVs in this standard and makes references to these levels where it is relevant.

Specifically, this Article accepts Level 3, 4, and 5 vehicles when referencing AVs. In Level 3, 4 and 5 vehicles, the automated driving system performs the entire driving task while it is engaged.\(^33\) However, there are some differences between Level 3, 4, and 5 vehicles. Level 3 vehicles, also referred to as conditional driving automation, operate within certain conditions and request a human occupant to take over the

\(^{32}\) SAE INT’L, TAXONOMY AND DEFINITIONS FOR TERMS RELATED TO DRIVING AUTOMATION SYSTEMS FOR ON-ROAD MOTOR VEHICLES, J3016 (Apr. 2021).

\(^{33}\) Id. at 28.
control of the vehicle in case of leaving these conditions or any system-related failure.\textsuperscript{34} Level 4 vehicles, referred to as high driving automation, also perform the entire driving task and operate within certain conditions as Level 3 vehicles; however, different from Level 3 vehicles, they do not need any intervention by a human occupant to prevent any risks because the automated driving system does itself.\textsuperscript{35} Different from Level 3 and 4 vehicles, Level 5 vehicles, called full driving automation, perform the entire driving task without any operational limitation.\textsuperscript{36} As Level 4 vehicles, the automated driving system in Level 5 vehicles itself performs certain measures to prevent the risk of harm.\textsuperscript{37}

In Level 0, 1, and 2 vehicles, a human driver performs all or part of the driving task.\textsuperscript{38} There are some automation features in Level 1 and 2 vehicles, yet this does not change the fact that human drivers must supervise the driving environment to take necessary actions, such as adaptive cruise control and lane-keeping system. Thus, Level 0, 1, and 2 vehicles are not within the scope of this Article but will make reference to them where relevant.

III. DEFINITION OF AVs AND TECHNICAL TERMS

A. The AV System

States fall into different categories in terms of how they define AV technology in the first place. Some states use the terms “autonomous mode,” “automated driving system” (ADS), “autonomous technology,” or “driving automation system” interchangeably to describe a system that can execute the dynamic driving task (DDT) with or without the presence of a human supervisor.\textsuperscript{39} This terminology is broad and

\begin{flushright}
\textsuperscript{34} \textit{Id.} \\
\textsuperscript{35} \textit{Id.} at 29. \\
\textsuperscript{36} \textit{Id.} \\
\textsuperscript{37} \textit{Id.} at 28. \\
\textsuperscript{38} \textit{Id.} at 28. \\
\end{flushright}
encompasses the capabilities of vehicles equipped with Level 3, 4, and 5 driving automation systems.40

Another common description adopted by other states uses the terms “automated driving system,” “autonomous technology,” or “self-driving technology” to encompass hardware and software that can execute all aspects of the DDT without human intervention.41 This definition is narrower than usage in the first group of states and excludes vehicles equipped with Level 3 driving automation systems, as it expects an ADS to perform all aspects of the DDT without limitation, which only Level 4 and 5 vehicles can achieve.

The third category defines “an automated driving system” as hardware and software that can collectively execute the entire DDT of the AV consistently, regardless of whether it is confined to a particular operational design domain (ODD).42 This definition takes into account


40 For example, the guidance released by the Pennsylvania Department of Transportation adopts the first type of definition for an ADS, and states that a highly automated vehicle equipped with such an ADS encompasses Level 3, 4, or 5 vehicles. The Pennsylvania Guidance, supra note 38, at 9. See Cal. Code Regs. tit. 13, § 227.02(b)(2) (2022) (stating that the capabilities of autonomous test vehicles equipped with such autonomous technology equates to Level 3, 4 and 5 vehicles as defined in SAE standards); Nev. Rev. Stat. § 482A.030 (2017) (defining an AV as a motor vehicle equipped with an ADS that falls within the standards of Level 3, 4, or 5 vehicles).


the technical capabilities of AVs in the present day and does not anticipate that AVs will be able to operate correctly in all conditions (e.g., environmental conditions, or time of day), thereby mainly including vehicles equipped with Level 3, 4 and 5 driving automation systems. In addition, the state of Utah defines each level of vehicles separately and in detail, mainly Level 5, Level 4, and Level 3 in parallel with the standard issued by the SAE International.

A single case, the District of Columbia describes an AV as a vehicle that can navigate roadways and interpret traffic control devices—traffic signals, traffic signs, pavement markings, and the like—without a human driver. This definition does not make any reference to an ADS and remains too vague in terms of the capabilities and limitations of AV technology.

Among these categories, the third category—especially Utah’s approach—appears to be an optimal regulation because it adopts the same terminology as the SAE standard adopted by the NHTSA. Therefore, this Article suggests that states adopt this third category to provide a standard terminology for all stakeholders.

Drawing on the delimited notion of an “automated driving system,” most states define an AV as any vehicle equipped with such a system.

MEMORANDUM]. The Illinois Executive Order, supra note 28, at (II)(1)(b) (defining automated vehicles equipped with such hardware and software); Ohio Exec. Order No. 2018-04K, 2 (May 9, 2018) [hereinafter The Ohio Executive Order].

The legislation of Utah and Maine, the guidelines of Massachusetts, and the executive order of Ohio adopt the third type of definition and explicitly state that ADS falls within Level 3, 4 or 5 driving automation system. UTAH CODE ANN. § 41-26-102.1(2)(b) (West 2022); H.P. 1204, 128th Leg., 2d Reg. Sess. (Me. 2018); THE MASSACHUSETTS MEMORANDUM, supra note 42, at 1(b); The Ohio Executive Order, supra note 42, at 2. The New Hampshire legislation adopts the third category, yet states that it accepts Level 4 and 5 vehicles according to the SAE classification under the definition of ADS. N.H. REV. STAT. ANN. § 242:1(II)(a) (2019).

Id. at (17).

Id. at (18).


For example, in its final rule, the NHTSA uses the term “automated driving system” that encompasses systems embedded in Level 3, 4, and 5 vehicles according to the SAE standard. NHTSA 2022, supra note 10, at 18560.

“driverless-capable vehicles,” or “highly automated vehicles”—these equate to only Level 4 and 5 vehicles. Hence, Level 3 vehicles are excluded from the definition of fully automated vehicles or driverless-capable vehicles in certain states. Understandably, some states aim to distinguish Level 3 vehicles from Level 4 and 5 vehicles that are classified as fully automated. Yet, states that only use the term fully automated vehicles, namely Georgia and Connecticut, exclude Level 3 vehicles from the definition, which will hamper the development of such vehicles in the future. Level 3 vehicles may require human...
intervention under some circumstances. However, this does not mean that they should be classified as Level 0, 1, or 2 vehicles. Unlike those at lower levels, Level 3 vehicles are capable of executing all aspects of the driving task and should be either distinguished separately or categorized with Level 4 and 5 vehicles.

The NHTSA employs another important term “ADS-equipped dual-mode vehicle.” An ADS-equipped dual-mode vehicle is capable of enabling not only driverless operation but also in-vehicle driver operation for complete trips.\(^5^4\) These kinds of vehicles will attract customers who would like to benefit from AV technology but continue to enjoy driving a motor vehicle when they desire. This is especially important during the transition period when the public would be hesitant about relinquishing all controls to the AV system and would still retain the opportunity to take the vehicle control back. Because of these reasons, states should implement the term “ADS-equipped dual-mode vehicle” in their regulations.\(^5^5\)

Overall, it appears that the significant inconsistencies between these definitions will confuse all stakeholders, including the public, researchers, state legislators, and manufacturers.\(^5^6\) For example, the American Automobile Association (AAA) conducted a survey of thirty-

---

\(^{54}\) NHTSA 2022, supra note 10, at 18561.

\(^{55}\) Without mentioning the term “ADS-equipped dual-mode vehicle,” the State of Arkansas approves the design of such vehicle that can function solely under automation or, alternatively, allow a human person to operate the vehicle when the ADS is deactivated. ARK. CODE ANN. § 27-51-2001(4) (2019).

four brands sold in the US and found that the terminology used to describe advanced driver-assistance systems (ADAS) varies widely and prioritizes marketing over clarity. The NHTSA is aware of this different usage and interpretations of terminology that would be confusing for all stakeholders and foresees this usage causing inconsistencies in terminology and confusion regarding the technology’s limitations. Thus, there is a crucial need for state regulators to adopt the terminology in the SAE standard to resolve this inconsistency, which resulted in confusion among all stakeholders.

B. Operator

Since Level 4 and 5 vehicles will not need any human intervention, there is no driving role for occupants or users of these vehicles. The presence of passengers or occupants in Level 4 and 5 vehicles does not mean that an AV is operated by a human driver/operator/user. Legislators, therefore, should expressly clarify the difference between “operating” a vehicle—such as providing directions and then sitting back in the driver’s seat to snack on chicken gyros and fries during the journey—and “operating a vehicle in a meaningful way,” which would involve taking control of the vehicle or disengaging the AV system.

The former “driver” is not “operating the vehicle in a meaningful way,” regardless of destination input.
For example, the State of Michigan uses the term “operator” to refer a person who “operates” an AV, and “operate” is defined as causing an automated motor vehicle to travel under its own power in automatic mode irrespective of whether a person is physically present in that vehicle. This usage implies that a person should not be necessarily in the vehicle but somehow resumes the control to initiate the operation of an AV, which could be done via a teleoperation system or an application.

Some states further define “driverless-operation” as the operation of an AV where (i) no onboard user is physically present; or (ii) no onboard user is a human driver or fallback-ready user. In parallel with this definition, some states define a passenger as a user who is physically present in a vehicle and plays no role in operating the vehicle. This definition ensures that human occupants/passengers/users/operators do not have any responsibility for the operation or supervision of Level 4 and 5 vehicles. However, one of the drawbacks of this definition is it does not address users’ role in providing destination information for Level 4 and 5 vehicles. For example, the State of North Carolina explicitly distinguishes the “operator” from “an occupant” who executes only strategic driving functions within a fully AV. Moreover, the user of a Level 4 vehicle could be categorized as a “passenger” where the vehicle system operates within its ODD, yet the same person could become “driver” shortly before or after the vehicle system is disengaged.

Relatively few states have appreciated that there will be distinctive categories of users of AVs, such as people with a disability, who cannot play a role in driving or supervising a vehicle but still need mobility.

On the other hand, some states describe an “operator” as a person who has actual physical control of a motor vehicle or an...
automated motor vehicle, thereby requiring that such person be physically present in the vehicle to resume physical control of an AV. This regulation maintains a more traditional position in defining “operator.” Although this regulation would encompass users of only Level 3 vehicles, it does not consider future users of Level 4 and 5 vehicles, such as people with disabilities, and thus would unnecessarily impose a duty on them. Moreover, it does not make sense to require physical control for users of Level 4 and 5 vehicles that can operate without any human intervention. Since the definition of “operator” varies significantly across states, a person deemed to be an operator in one state—regardless of his or her physical presence in a vehicle in that state—would not necessarily be deemed so in another.

At the federal level, the NHTSA did not amend the definition of “driver” in its final rule. The Agency justified this decision on many grounds, including that it would be inappropriate to change this definition in a rulemaking that focuses exclusively on the 200-series

---


71 Otherwise, people with disability will be subject to regulations that define “conventional human driver” or “human driver” as a natural person who manually operates a motor vehicle by exercising in-vehicle breaking, accelerating, steering, and selecting gears. IOWA CODE ANN. § 321.514(2) (2019); NEB. REV. STAT. ANN. § 60–3301(3) (2018); N.H. REV. STAT. ANN. §242:1(II)(c) (2019); N.D. CENT. CODE ANN. §39–01–01.2(1)(d) (2019) (also including the requisite of a valid license); LA. REV. STAT. ANN. § 32:400.1(5) (2019); UTAH CODE ANN. § 41–26–102.1(4) (2022); VT. STAT. ANN. TIL. 23, § 4202(4) (2019).


73 49 C.F.R. § 571.3 (“Driver means the occupant of a motor vehicle seated immediately behind the steering control system.”).

74 NHTSA 2022, supra note, at 18566. However, the NHTSA has enacted two new definitions—namely “driver’s designated seating position” and “manually operated driving controls—and clarified the term “steering control system.” 49 C.F.R. § 571.3. (“Driver's designated seating position means a designated seating position providing immediate access to manually operated driving controls.”); 49 C.F.R. § 571.3. (“Manually operated driving controls means a system of controls: (i) That are used by an occupant for real-time, sustained, manual manipulation of the motor vehicle's heading (steering) and/or speed (accelerator and brake); and (ii) That is positioned such that they can be used by an occupant, regardless of whether the occupant is actively using the system to manipulate the vehicle's motion.”); 49 C.F.R. § 571.3. (“Steering control system means the manually operated driving control used to control the vehicle heading and its associated trim hardware, including any portion of a steering column assembly that provides energy absorption upon impact.”) The NHTSA made clear that the definition “manually operated driving controls” is enacted to encompass traditional driving controls, not future controls that have not been developed yet, such as tablets or cellphones. NHTSA 2022, supra note 10, at 18568.
FMVSSs.\textsuperscript{75} Yet, the NHTSA promised to revisit the definition “driver” when defining the ADS itself in a different context.\textsuperscript{76} This incubation period should not last longer, as many states need the NHTSA’s pioneering role in changing such a fundamental concept.

At the other end of the spectrum, users of Level 3 vehicles need specific regulatory attention, as they can assume a role in the driving task if the AV system so requests. The state of Utah defines a fallback ready user specifically for Level 3 vehicles as a human driver who is ready to operate such vehicles in case a system failure occurs or the system request an intervention.\textsuperscript{77} This regulation correctly distinguishes Level 3 vehicles from other vehicles and should be adopted by other states that do not have a similar regulation. The development of Level 3 vehicles will be hindered if there is no specific regulation that addresses the unique circumstances of these vehicles. This need will likely become ubiquitous, as the state of Nevada has recently approved a Level 3 vehicle manufactured by Mercedes for complying with its regulations and became the first state to take this decision.\textsuperscript{78}

C. Classification

In order to facilitate healthy discussion about AV technologies, it would be useful to define categorical divisions for AVs based on the functional capabilities and limitations of the automation and the role of the driver in the driving task.\textsuperscript{79} The Guidance adopts the classification established by the SAE International definitions.\textsuperscript{80} One of the most controversial issues regarding classification is how to distinguish Level 3, 4, and 5 vehicles.

\textsuperscript{75} Id.
\textsuperscript{76} Id.
\textsuperscript{77} UTAH CODE ANN. § 41–26–102.1(14) (2022). Also, the SAE provided a similar but more detailed definition for “fallback ready user”:

The user of a vehicle equipped with an engaged Level 3 ADS feature who is properly qualified and able to operate the vehicle and is receptive to ADS-issued requests to intervene and to evident DDT performance-relevant system failures in the vehicle compelling him or her to perform the DDT fallback.

SAE 2021, supra note 67, at 22.
\textsuperscript{78} Andrew J. Hawkins, Mercedes-Benz is the First to Bring Level 3 Automated Driving to the US, THE VERGE (Jan. 27, 2023, 9:02 PM), https://www.theverge.com/2023/1/27/23572942/mercedes-drive-pilot-level-3-approved-nevada [https://perma.cc/SW75-XW74].
\textsuperscript{79} Frank Barickman et al., Key Considerations in the Development of Driving Automation Systems, 24\textsuperscript{th} INT’L TECHNICAL CONF. ON THE ENHANCED SAFETY OF VEHICLES (ESV) 13 (2015).
\textsuperscript{80} NHTSA 2018, supra note 23, at vi; NHTSA 2017, supra note 18, at 1; NHTSA 2016, supra note 17, at 9.
vehicles from Level 2 vehicles. The Guidance recognizes that the distinction between Level 2 and higher levels is not entirely clear for users and the public and predicts that system’s expectations of drivers’ supervisory role and drivers’ demonstrated understanding of that role may differ significantly.  

Thus, the Guidance explains the main difference between Level 3, 4, and 5 vehicles and Level 2 vehicles is that the driver of a Level 2 vehicle remains continuously engaged in the driving task by monitoring the proper operation of the system and taking immediate control where necessary—with or without a warning from the system. However, the Guidance does not provide enough certainty for the difference between Level 2 and higher levels, especially Level 3 in which a human driver retains an important role. A clear distinction between a Level 2 vehicle and higher levels would be beneficial. A human driver in a Level 3 vehicle need not continuously engage in the driving task and monitor the proper operation of the system until he or she is alerted to intervene by the system. His or her role in a Level 3 vehicle includes “passive monitoring” for both automation system and takeover requests. For example, a human driver’s visual attention is not required to watch the roadway for executing the Object and Event Detection and Response (OEDR) subtask of the DDT, but he or she still has a role in being sufficiently aware to “sense” a takeover request. Conversely, a Level 2 vehicle necessitates an active and continuing duty by a human driver to monitor the driving environment and take appropriate action. The NHTSA, therefore, should clarify this distinction either in future guidance or in a FMVSS on AVs.

D. Dynamic Driving Task

The capabilities and limitations of AVs need to be tested and clearly specified and tested before they can be deployed on public roads, just as human drivers require extensive driving lessons even before taking

---

81 NHTSA 2016, supra note 17, at 32.
82 Id. at 10.
83 See, e.g., Barickman et al., supra note 79, at 6 (“Active supervision of the automation operation or the driving environment is not part of the driver’s role in Level 3 automated operation.”); Andrew Marinik et al., U.S. DEP’T OF TRANSP. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., DOT HS 812 044, Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts, at 2 (2014) (“The major distinction between L2 and L3 is that at L3, the vehicle is designed so that the driver is not expected to constantly monitor the roadway while driving.”).
84 Barickman et al., supra note 79, at 6.
85 Id.
86 Id. at 8.
the formal test to obtain a license. The Guidance, therefore, attempts to define a DDT as the real-time operational and tactical functions essential to operate a vehicle in traffic, yet excluding strategic functions such as trip scheduling and selection of destinations and waypoints.\textsuperscript{87} This definition implies that AVs will evolve as an object confined to our destinations and waypoints instead of independent subjects that can operate freely.\textsuperscript{88} This is a valid policy given the capabilities not only of AVs but also other AI-supplied products.

One of the subtasks of the DDT is the OEDR actions. Specifically, this refers to the detection by the driver or AV system of any circumstance that require some modification to the immediate driving task, along with the adaptation by the appropriate driver or AV system response to such circumstances.\textsuperscript{89} An AV's OEDR should:

(i) detect and respond to other vehicles—in and out of its travel path—pedestrians, cyclists, animals, and objects that could impact the safe operation of the AV and;

(ii) deal with various conditions, such as emergency vehicles, temporary work zones, other unusual conditions (e.g., police manually directing traffic, construction worker controlling traffic, emergency response workers) that may affect safe operations of an AV.\textsuperscript{90}

In addition, an ADS should safely navigate unpredictable hazards, obstacles, and interactions with other vehicles and pedestrians who may not necessarily comply with the traffic laws and follow expected patterns of behavior.\textsuperscript{91} A well-defined ODD is imperative to determine what OEDR capabilities are essential for AVs to effectively operate within the intended domain.\textsuperscript{92} The AV system is deemed to be responsible for achieving the OEDR within its ODD and when automation is actively engaged.\textsuperscript{93}

Behavioral competency, on the other hand, is described as the ability of an AV to operate in the traffic conditions that it will regularly confront—such as keeping the vehicle in the lane, complying with traffic laws, following acceptable behavior, and responding to other vehicles, road users, and frequently confronted hazards.\textsuperscript{94} Similarly, the

\textsuperscript{87} NHTSA 2018, supra note 23, at 46.
\textsuperscript{88} See also Bartosz Brożek & Marek Jakubiec, On the Legal Responsibility of Autonomous Machines, 25 ARTIFICIAL INTELLIGENCE & L 293, 303 (2017) ("[A]utonomous machines cannot be granted the status of legal agents.").
\textsuperscript{89} NHTSA 2017, supra note 18, at 7; NHTSA 2016, supra note 17, at 28.
\textsuperscript{90} NHTSA 2017, supra note 18, at 7; NHTSA 2016, supra note 17, at 28.
\textsuperscript{91} NHTSA 2018, supra note 23, at 7.
\textsuperscript{92} NHTSA 2016, supra note 17, at 27.
\textsuperscript{93} Id. at 28; NHTSA 2017, supra note 18, at 6.
\textsuperscript{94} NHTSA 2017, supra note 18, at 7; NHTSA 2016, supra note 17, at 28.
behavioral competencies that a specific AV is capable of regularly performing are directly pertinent to the AV system, its intended ODD, and the fallback method. The main difference between OEDR and behavioral competency seems to be that OEDR addresses imminent driving tasks, whereas behavioral competency focuses on everyday driving tasks.

Some states provide definitions for DDT parallel with the Guidance’s definition and offer an optimal regulation given its inclusiveness and compatibility with the SAE standard. However, some states wrongly define the DDT. For example, the state of North Carolina does not explicitly mention ODD and exclude strategic functions in the definition of DDT. Some states exclude strategic functions, yet do not confine DDT to any ODD. Excluding strategic functions from the definition of DDT prevents misperceptions that AVs will evolve as subjects in our legal environment. The reason the selection of destinations, waypoints, or trip scheduling should be excluded from DDT is that this freedom will be provided for occupants who travel on an AV rather than the vehicle itself. This reflects the notion that humans must control and benefit from AI, and such technology must not evolve as an autonomous agent, at least for a foreseeable future.

Hence, the absence of ODD in the definition of DDT would not be compatible with the definition of AVs that those states adopted to include Level 3, 4 and 5 vehicles, as Level 3 and 4 vehicles are confined to a specific ODD. Apart from that, confining the ability to achieve the DDT to ODD is consistent with the state-of-the-art of AV technology which still struggles to properly operate in poor weather conditions or

---

95 NHTSA 2017, supra note 18, at 7; NHTSA 2016, supra note 17, at 29.
97 N.C. GEN. STAT. ANN. § 20–400(2) (1996) (defining DDT as all of the real-time operational and tactical functions which are essential to operate a motor vehicle in motion).
rough terrain. Those states that accepted a combination of Level 3, 4 and 5 vehicles under the definition of AVs, therefore, incorrectly regulated the DDT part of AV technology.\textsuperscript{100}

Further, some states provide examples of DDT, such as (i) lateral vehicle motion through steering; (ii) longitudinal motion control through acceleration and deceleration; (iii) supervising the driving environment through object and event detection, recognition, classification, and response preparation; (iv) object and event response execution; (v) maneuver planning; and (vi) increasing prominence through signaling, lighting, and gesturing.\textsuperscript{101}

The first problem with this definition is the inclusion of “gesturing” under the DDT. It is essential to interpret hand gestures and eye contact in traffic, and AVs would need to be able to interpret these gestures in order to integrate into our society.\textsuperscript{102} Such communication requires “a reflexive attentiveness to the communication partner and mutual perception”\textsuperscript{103} and that would not be technically achievable for today’s AVs in which no human drivers in the driver’s seat to make a gesture.\textsuperscript{104} Therefore, this action should not be included in the definition

\textsuperscript{100} These states are Arkansas, Alabama, California, Connecticut, Louisiana, Michigan, Oklahoma, Utah, Arizona, Massachusetts, Pennsylvania.

\textsuperscript{101} ARK. CODE ANN. § 27-51-2001(3)(A) (2019) (providing the same tasks, except the task of gesturing to increase conspicuity); N.C. GEN. STAT. ANN. § 20-400(2) (1996); OKLA. STAT. ANN. tit. 47, § 1701(B) (2021); UTAH CODE ANN. § 41-26-102.1(11)(a) (2022); THE MASSACHUSETTS MEMORANDUM, supra note 42, 1(f); ARIZ. REV. STAT. § 28-101(27)(b) (2022). Also, other states provide examples of the operational aspects of driving skills such as steering, braking, accelerating, supervising the vehicle and roads, and for the tactical aspects of driving skills such as responding to traffic scenarios, changing lanes, turning, using traffic signals. CAL. CODE REGS. tit. 13, § 227.02(g) (2018) (providing similar examples); LA. STAT. ANN. § 32:1(1.2)(b)(iii)(v) (2022) (the same); MICH. COMP. LAWS ANN. § 257.2b(1)(a)(b) (2023) (the same); TENN. CODE ANN. § 55-8-202(b)(4)(6) (2021); TEX. TRANSP. CODE ANN. § 545.451(3) (2017) (the same); UTAH CODE ANN. § 41-26-102.1(20) (2022) (defining object and event recognition as the subtasks of the dynamic driving); THE PENNSYLVANIA GUIDANCE, supra note 39, at 9.


\textsuperscript{103} Tom Michael Gasser, Fundamental and Legal Questions for Autonomous Vehicles, AUTONOMOUS DRIVING: TECHNICAL, LEGAL AND SOCIAL ASPECTS, supra note 31, at 523, 541.

\textsuperscript{104} See also Berthold Färber, Communication and Communication Problems Between Autonomous Vehicles and human Drivers, in AUTONOMOUS DRIVING: TECHNICAL, LEGAL AND SOCIAL ASPECTS, supra note 31, at 125, 142 (arguing that interpersonal negotiations might evolve as varying levels of intensity, and a problem arises due to the fact that the AV system is unrecognizable); Gasser, supra note 103, at 541 (arguing that AVs would not be able to possess the human–specific capability of communicating through unspecified means). This may not be the case for a vehicle equipped with a Level 3 ADS since occupants of such vehicles would prefer to seat in the driver’s seat and be ready to take over upon a request by the vehicle.
of DDT unless technology is developed that could mimic human gesturing. For example, the State of Arkansas does not include gesturing as a DDT.\textsuperscript{105}

Second, and more importantly, the elements of DDT in fact fall within the performance of AVs that the U.S. DoT has claimed exclusive responsibility for.

E. Operational Design Domain

ODD is the next most frequently used term in the definition of AVs, DDT, and minimal risk conditions. The Guidance addresses AVs that will not operate everywhere, namely Level 3 and 4 vehicles, and thus, it defines ODD—which may differ for each AV system—as the conditions where an AV is intended to operate correctly. It refers to roadway types, geographical location, speed range, lighting conditions for operation, day and/or night conditions, weather conditions, and other operational domain constraints.\textsuperscript{106} Identification and definition of ODD are difficult, even rain droplet sizes or a type of rain could change an AV’s ODD.\textsuperscript{107}

The Guidance recommends that manufacturers or other entities define and document the ODD for each AV.\textsuperscript{108} The ODD will be crucially important in assessing the safe operation of AVs, as the U.S. DoT expects that an AV be able to operate safely within its intended ODD and transit to a minimal risk condition when it leaves its ODD or conditions dynamically change to fall outside of its ODD.\textsuperscript{109}

The common definition of ODD found in state regulations is the same as the Guidance’s definition.\textsuperscript{110} However, assessing an ODD for

\textsuperscript{105} ARK. CODE ANN. § 27–51–2001(3)(A).
\textsuperscript{106} NHTSA 2018, supra note 23, at 46; NHTSA 2017, supra note 18, at 6; NHTSA 2016, supra note 17, at 13–27.
\textsuperscript{108} NHTSA 2018, supra note 23, at 39; NHTSA 2016, supra note 17, at 13–27.
\textsuperscript{109} NHTSA 2018, supra note 23, at 39; NHTSA 2017, supra note 18, at 6; NHTSA 2016, supra note 17, at 27.
\textsuperscript{110} ALA. CODE § 32–9B–1(7); ARK. CODE ANN. § 27–51–2001(6); CAL. CODE REGS. tit. 13, § 227.02(j); CONN. GEN. STAT. ANN. § 13a–260(a)(4); FLA. STAT. ANN. § 316.003(3)(d); GA. CODE ANN. § 40–1–1(37.1); IOWA CODE ANN. § 321.514(7); LA. STAT. ANN. § 32:400.1(8); NEB. REV. STAT. ANN. § 60–3301(9); NEV. REV. STAT. ANN. § 482A.046; N.H. REV. STAT. ANN. § 242:1(II)(i); N.C. GEN. STAT. ANN. § 20–400(6); N.D. CENT. CODE ANN. § 39–01–01.2(1)(f); VT. STAT. ANN. tit. 23, § 4202(9); ARIZ. REV. STAT.
each AV may require assessing performance of AVs, which again the U.S. DoT seeks to regulate exclusively.

The operation of Level 3 and 4 vehicles, apart from Level 5 vehicles, is limited to certain operational design domains because these vehicles may face technical problems when they leave their ODD. It is logical to accept ODD for AVs, yet such domains should be specified explicitly for each AV. If a certain ODD is not clarified for each AV, a manufacturer would claim that its vehicles are not designed to function effectively in the domain where the accident occurred. A clearly identified ODD, therefore, would have a decisive role in litigation in the future.

F. Minimal Risk Condition

The next term directly related to the ODD is minimal risk condition. According to the Guidance, minimal risk condition means a state to which a user or an ADS may bring a vehicle after experiencing the DDT fallback to minimize the risk of a collision when a trip cannot or should not be continued. Not every minimal risk condition is defined in detail since they differ due to the type and extent of a given failure. One example is to bring the vehicle automatically and safely to a complete stop—preferably outside of an active lane of traffic. A safe transition to minimal risk condition will likely be an essential component of AV safety, depending on its capabilities and application.

When we look at state regulations, we see inconsistency among definitions. First, in parallel with the Guidance, some states describe a minimal risk condition as a mode that a user or an ADS can activate in order to minimize the risk of an accident in case a trip cannot or should not be completed, or the AV system fails such that the DDT is

§ 28-101(55); H.P. 1204 128th Maine Legislature, Section 1 (Me. 2018); THE MASSACHUSETTS MEMORANDUM, supra note 42, I(r) at 4; THE PENNSYLVANIA GUIDANCE, supra note 39, at 9; UTAH CODE ANN. § 41–26–102.1(23) (also encompassing traffic characteristics); Mass. Dep’t of Transp., Application to Test Automated Driving Systems on Public Ways in Massachusetts, at 4 (2019), https://www.mass.gov/files/documents/2016/11/pg/eo572.pdf (providing examples for operational design domains such as daytime or nighttime as a time of day, heavy rain and fog, heavy snow, severe weather as environmental conditions, multi–modal (mixed traffic) and single or multiple lanes as road typologies and speeds, construction–active work–school zones, or unprotected left turns as situational constraints).

111 DDT fallback is the response by the user or by the ADS to either execute the DDT or achieve a minimal risk condition in case of a DDT–related failure or ODD exit. NHTSA 2018, supra note 23, at 46.

112 Id.; NHTSA 2017, supra note 18, at 8; NHTSA 2016, supra note 17, at 30.

113 NHTSA 2017, supra note 18, at 8; NHTSA 2016, supra note 17, at 30.

114 ARIZ. REV. STAT. § 28-101(45).
incapacitated.\textsuperscript{115} This definition includes Level 3, 4 and 5 vehicles, yet is narrow in the sense that it confines the transition to a minimal risk condition to reduce the risk of an accident. However, minimal risk conditions should encompass other internal failures, such as any malfunctioning in the system or sensor failures even if they do not necessarily lead to accidents.

Second, some states describe a minimal risk condition as a low-risk operating condition that an AV resorts to where either the AV system has failed or a human driver could not respond to a take-over-request\textsuperscript{116} to perform the driving task.\textsuperscript{117} Since this definition additionally assumes the possibility of human intervention following a take-over-request, it is more general and likely to include Level 3 vehicles.

Third, other states describe a minimal risk condition as a condition wherein the AV confronts a failure of the ADS that causes an inability to execute the DDT and aims to achieve a reasonably safe state, \textit{i.e.} stopping the AV completely, pulling the vehicle over to the nearest side of the road, and turning on emergency lights.\textsuperscript{118} This definition is narrower and only encompasses Level 4 and 5 vehicles, since it does not mention human intervention, which is the case in Level 3 vehicles. Therefore, states that have included Level 3 vehicles within their definition of AVs have regulated this aspect of AVs incorrectly.\textsuperscript{119} For

\textsuperscript{115} ALA. CODE § 32-9B-1(6); LA. STAT. ANN. § 32:400.1(7); UTAH CODE ANN. § 41–26-102.1(19); THE MASSACHUSETTS MEMORANDUM, supra note 42, 1(j).

\textsuperscript{116} A few states define a request to intervene separately. For example, some states define a request to intervene as an alert sent by an ADS to a fallback-ready user informing that the fallback-ready user should immediately take control of the operation of the vehicle. N.C. GEN. STAT. ANN. § 20–402(a); UTAH CODE ANN. § 41–26–102.1(28); ARIZ. REV. STAT. § 28-9601(2) (using the term “human driver” instead of a fallback-ready user). Moreover, the State of Utah separately defines an external event, as it is related to the DDT, as a situation in the driving environment that requires a response by a human driver or driving automation system. \textit{Id.} § 41–26–102.1(13). These regulations are important to clarify the role of a human driver in Level 3 vehicles.

\textsuperscript{117} CAL. CODE REGS. tit. 13, § 227.02(1); FLA. STAT. ANN. § 319.145 (2)(2) (including a failure to intervene and a system failure and defining a minimal risk condition as a reasonably safe state, such as bringing the vehicle to a complete stop and activating the vehicle’s hazard lamps); THE PENNSYLVANIA GUIDANCE, supra note 39, at 9. (also including other reasons that lead to the inability of the system to perform fully or completely the DDT).

\textsuperscript{118} ARK. CODE ANN. § 27–51–2001(5); FLA. STAT. ANN. § 319.145 2(3); GA. CODE ANN. § 40–1–1(27.1); IOWA CODE ANN. § 321.514(5); NEB. REV. STAT. ANN. § 60–3301(7); NEV. REV. STAT. ANN. § 482A.044; N.H. REV. STAT. ANN. § 242:1(II)(g); N.C. GEN. STAT. ANN. § 20–400(4); N.D. CENT. CODE ANN. § 39–01–01.2(1)(e); TENN. CODE ANN. § 55– 30–102(5) and § 55–8–101(40); VT. STAT. ANN. tit. 23, § 4202(8).

\textsuperscript{119} These states are Arkansas, Georgia, Iowa, Nebraska, Nevada, New Hampshire, North Carolina, North Dakota, Vermont.
example, the State of Florida defined minimal risk conditions separately for fully AVs (Level 4 and 5) and other AVs (Level 3).¹²⁰

Reading these definitions together reveals some notable points about our discussion. To start with, if an AV achieves a minimal risk condition during a system malfunction¹²¹ or where there is a risk of an accident, the occupants of the AV, other road users, and the public generally will be better off in terms of safety. A minimal risk condition should be the required benchmark in case of system failure or risk of accident, and both situations should be explicitly mentioned in the definition of a minimal risk condition or an AV. States should adopt the second definition given its inclusiveness because it deems a minimal risk condition as a low-risk operating condition that an AV resorts to in case of system failure or human driver's failure to take over.

Next, even though an AV comes to a complete of stop or its emergency lights trigger during the low-risk operating mode, such actions are necessary but not sufficient to secure the safety of occupants and other road users. Some traffic scenarios will result in accidents—also known as inevitable crash scenarios. Minimal risk condition, as defined currently in state regulations and the Guidance, says nothing about these inevitable crash scenarios. How AVs should behave in case of accidents, thus, lacks clear guidance.¹²² As such, it is one of the missing parts concerning the application of minimal risk conditions.

Lastly, states do not provide any guidance in the definition of the minimal risk condition about what an AV should do after an accident. For example, a crash may occur in the middle of a freeway and the system should guide the vehicle to the side of the road in order to reduce the risks of other possible accidents.

IV. OPERATION AND TESTING REQUIREMENTS FOR AVs

A. Driver Requirements

In order to carry out testing or operating AVs in a specific state, there are strict rules that each manufacturer or entity must satisfy. The Guidance suggests that vehicles being tested should be operated only by

¹²¹ Some states give examples for the reasons for such system failures, such as a malfunction in a driving automation system and/or other vehicle systems that hinder the driving automation system from safely performing some or all aspects of the DDT. Utah Code Ann. § 41–26–102.1(30); The Massachusetts Memorandum, supra note 42, 1(y).
persons designated by the manufacturer or other entity that have received training and instruction regarding the capabilities and limitations of the vehicle and have a valid state driver’s license.\textsuperscript{123} The Guidance recommends holding test operators responsible for complying with all traffic rules, leaving them subject to a penalty for all traffic violations.\textsuperscript{124}

When we look at state regulations, the first and foremost common requirement is that the manufacturer shall ensure that a driver is seated in the driver’s seat to monitor the operations of the vehicle and take over the control of it, if necessary.\textsuperscript{125} A driver usually is required to have a driver’s license to operate a vehicle\textsuperscript{126} and is expected to be ready to take control of the vehicle at all times.\textsuperscript{127}

Driver requirements generally follow the requirements that are established for a conventional driver. However, the driver requirements may not serve the purpose of developing a safe and reliable AV technology because human drivers are likely to fail to supervise the vehicle.\textsuperscript{128} Second, even though such license requirements are designed

\begin{itemize}
  \item \textsuperscript{123} NHTSA 2018, supra note 23, at 30–7; NHTSA 2017, supra note 18, at 23–4; NHTSA 2016, supra note 17, at 43.
  \item \textsuperscript{124} NHTSA 2017, supra note 18, at 24; NHTSA 2016, supra note 17, at 43.
  \item \textsuperscript{125} CAL. CODE REGS. tit. 13, § 227.26(c) and § 227.32(a); CAL. VEH. CODE § 38750 (b)(2); CONN. GEN. STAT. ANN. § 13a–260(d)(1); D.C. CODE ANN. § 50–2352(2); IOWA CODE ANN. § 321.515(2)(a); LA. REV. STAT. ANN. § 32:400.3(A); Mich. Comp. Laws ANN. § 257.665(2); NEB. REV. STAT. ANN. § 60–3303(1); Nev. Rev. Stat. Ann. § 482A.070(1)(a)(b); N.H. Rev. Stat. Ann. § 32:400.3(A); Mich. Comp. Laws ANN. § 257.665(2); VT. STAT. ANN. tit. 23, § 4203(h)(1); 2017 N.Y. AB 9508 Section 1(a); The Illinois Executive Order, supra note 28, (II)(2) at 2–3; The Massachusetts Executive Order, supra note 28, Section 4; The Massachusetts Memorandum, supra note 42, 3(m) at 6; The Pennsylvania Guidance, supra note 39, 5(e) at 3; State of Washington Executive Order 17–02, Autonomous Vehicle Testing & Technology in Washington State and Autonomous Vehicle Work Group at 2 [hereinafter The Washington State Executive Order], http://governor.wa.gov/sites/default/files/exec_order/17–02AutonomousVehicles.pdf (last accessed on July 2, 2020); Ariz. Rev. Stat. § 28-9602(B).
  \item \textsuperscript{127} See also Daniel A. Crane et al., A Survey of Legal Issues Arising from the Deployment of Autonomous and Connected Vehicles, 23 Mich. Telecomm. & Tech. L. Rev. 191 (2017) ("State regulations that require a licensed operator in the car would essentially
to ensure safe operation and testing of AVs, they will not be welcomed by people with disabilities who look forward to reaping the benefits of AVs to be able to travel any time. A person with disability speaking at a workshop stated that:

"I am thinking that the requirement of driver license is kind of shortsighted . . . because it takes away some of the incentivize of developing a self-driving car, because if it is not truly a self-driving and requires someone present who has a license, then that kind of defeats the purpose in my mind. I am a real proponent of safety, so I understand your concerns for that, but truthfully, I have written so many human drivers . . . who have road rage, look at their cell phones, and I'd rather almost be in a driverless car. So I believe that the standards could be such that you know perhaps people who operate one of these cars would need to have some forms of identification and that kind of thing, but to require them to have a license is counterproductive to whole notion in my mind of a self-driving car. And it really does limit the participation by a vast majority of the disability population who longed for this advancement in technology, who longed for the freedom for once in their life to be able to get where they want to go on their own without being dependent on someone else to take them there."

Some states, on the other hand, have permitted testing or operation of Level 4 and 5 AVs without a test/human driver. For eliminate the possibility of one of the business models for autonomous vehicles.")}; But see Caitlin Brock, Where We’re Going, We Don’t Need Drivers: The Legal Issues and Liability Implications of Automated Vehicle Technology, 83 UMKC L. REV. 769, 781 (2015) ("Revise state vehicle codes to expressly mandate that a human driver be present in a vehicle, regardless of whether they are doing the actual driving or not.").

129 California DMV, Autonomous Vehicle, YOUTUBE (Feb. 16, 2016) at 12:00–14:13, https://www.youtube.com/watch?v=nQx3nWWEeVA).

130 Id.

example, Nuro, an AV delivery company, became the first company to receive a permit to operate its AVs commercially in two counties of California from the CDMV. The Guidance and other states take a more cautious approach than these states by suggesting that designated drivers must operate the vehicle. Also, there are inconsistencies among states for AV manufacturers in terms of driverless operation.

B. Performance Requirements

AVs are required to achieve a minimal risk condition when the AV system fails, causing the vehicle to be unable to execute the DDT in its relevant ODD in certain states. Two states also explicitly require an

545.454(a) (2017); UTAH CODE ANN. § 41–26–103(2) (2022); ARIZ. REV. STAT. § 28-9602(C) (2021); The Washington State Executive Order, supra note 125, at 3. But see COLO. REV. STAT. §42–4–242(1) (2017) (stating that any person can use a Level 4 or 5 vehicle to drive a motor vehicle or to have a control on a function of a motor vehicle, yet not clear whether a human driver must be seated in the vehicle or not). Some states mandate that in these cases, a remote operator can connect to the car via a communication link that provides information on its location and status. CAL. CODE REGS. tit. 13, § 227.38(b)(1) (2022); FLA. STAT. ANN. § 316.85(5) (2019); The Ohio Executive Order, supra note 41, at 6.

David Estrada, California DMV Grants Nuro First Ever AV Deployment Permit, MEDIUM (Dec. 23, 2020), https://medium.com/nuro/california-dmv-grants-nuro-first-ever-av-deployment-permit-ca424ebd2 (for companies such as Nuro, whose AVs deliver grocery, takeaways, and the like instead of carrying people, some states have recently enacted legislation that is more specific and better to address AV developers like Nuro. According to this legislation, “neighborhood occupantless vehicle” or “low-speed autonomous delivery vehicle” are defined as a low-speed vehicle that is an AV, operates without a human occupant, and transports cargo). N.C. GEN. STAT. § 20–4.01(23a) (2020); NEV. REV. STAT. ANN. § 484B.637(4) (2021) (adopting a similar definition); FLA. STAT. ANN. § 316.003(39) (these are specific rules also adopted for neighborhood occupantless vehicles regarding their operational design domain, such as operating on streets and highways where the speed limit is not more than 45 miles). N.C. GEN. STAT. § 20–121.2 (2021); NEV. REV. STAT. ANN. § 484B.637(3) (2021); FLA. STAT. ANN. § 316.2122 (2021) (the normal speed limit is 35 miles per hour but allowing 45 miles per hour under some circumstances). This makes sense given that Nuro’s vehicles are small and operating at slow speeds, designed for carrying groceries, takeaways, and other types of cargos. Moreover, the NHTSA tailored the 200-series FMVSSs to exclude occupantless vehicles that do not have no designated seating positions because a safety need does not exist to apply the existing 200-Series standards to these vehicles. NHTSA 2022, supra note 10, at 18572.

AV to make a request to intervene in the event of a system failure.\textsuperscript{134} For Level 3 vehicles, the State of California requires AVs to stop safely after a technical failure that would put occupants and other road users at risk in these vehicles in which the driver does not or is not able to take control of the vehicle.\textsuperscript{135}

Some states mandate that the system, in a fully AV, must be capable of undertaking any physical acts which would otherwise be fulfilled by a human driver.\textsuperscript{136} However, this requirement is impossible for AVs to achieve for now. Only a human driver can achieve particular acts, such as gesturing and therefore, this requirement should exclude such tasks. For example, the state of Nevada excluded particular acts that could not be fulfilled by an AV system because of their nature.\textsuperscript{137}

All of these requirements are related to the performance of AVs and falls under federal authority. Hence, these states have the potential to trespass on the authority of the U.S. DoT, which seeks exclusive jurisdiction to regulate the performance of AVs.

C. Compliance with Federal and State Law

The promising feature of AVs is significant reductions in traffic accidents, injuries, and deaths due to better compliance with traffic laws, which human drivers are notorious for violating.\textsuperscript{138} The Guidance rightfully sets out that the AV should obey applicable traffic laws and comply with the rules of the road within the region of operation, based on its ODD.\textsuperscript{139}

Enacting special traffic rules for AVs would generate unpredictability and confusion for other conventional vehicles and road users during the transition period, so requiring test AVs to be able to

\textsuperscript{6} The Washington State Executive Order, \textit{supra} note 125, at 3; \textit{ARIZ. REV. STAT. \textsection 28-9602(C)(2)(b) (2021)}.

\textsuperscript{134} \textit{MICH. COMP. LAWS ANN. \textsection 257.665(2) (2022)}; \textit{UTAH CODE ANN. \textsection 41-26-103(1)(c) (2022)}.

\textsuperscript{135} \textit{CAL. CODE REGS. tit. 13 \textsection 228.06(c)(2) (2018)}.


\textsuperscript{137} \textit{NEV. REV. STAT. ANN. \textsection 482A.200 (2017)}.

\textsuperscript{138} \textit{See, e.g., U.S. DEP’T OF TRANSP NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., DOT HS 811 059, NATIONAL MOTOR VEHICLE CRASH CAUSATION SURVEY: REPORT TO CONGRESS (2008) (finding that 93 percent of accidents are caused by driver errors)}.

\textsuperscript{139} \textit{NHTSA 2017, supra note 18, at 15; NHTSA 2016, supra note 17, at 25. Since these traffic laws may differ in each state, or even each city, entities are recommended to design processes that allow to update and adapt AV systems to satisfy new legal requirements. NHTSA 2017, supra note 18, at 15; NHTSA 2016, supra note 17, at 26.}
comply with existing traffic rules is the optimal choice.140 Thus, a new FMVSS requiring assessment of whether AVs are capable of operating in accordance with the traffic laws—such as stopping at red lights, yielding to a pedestrian at pedestrian crossings, not speeding—should be implemented as a performance standard and tested, either in simulations or under controlled real-life environments.

However, experience tells us that traffic rules may need to be broken in order to reduce the risk of accidents or to prevent more serious risks from occurring.141 Violations of some traffic rules are thus needed for machine learning in the regulation of AVs. Doing so helps AVs “learn” how to minimize the risk of accidents or avoid them altogether and escape severe accidents when they are occurring. As a result, rules violations like speeding in order to keep up the traffic flow or to facilitate emergency operations enhance traffic safety and public welfare.142 In light of this argument, the Guidance shrewdly suggests that AVs should have the freedom to violate a given motor vehicle driving law in certain safety-critical situations just as human drivers are permitted to do so.143

Some commentators asserted that the status quo permitting humans to violate traffic rules should not be transferred to AVs, but instead reformulated, thereby incentivizing human drivers to obey traffic rules, and increasing the appeal of AVs.144 This view suggests

---

140 Ronald Leenes & Federica Lucivero, Laws on Robots, Laws by Robots, Laws in Robots: Regulating Robot Behaviour by Design, 6 L. INNOVATION & TECH. 193, 208 (2014) (“[[It seems obvious that driverless vehicles should observe traffic laws if they are to intermingle with human driven cars.”].


142 Antje von Ungern-Sternberg, Autonomous Driving: Regulatory Challenges Raised by Artificial Decision-Making and Tragic Choices, in RESEARCH HAND ARTICLE ON THE LAW OF ARTIFICIAL INTELLIGENCE 251, 263 (Woodrow Barfield & Ugo Pagallo eds. 2018).’

143 NHTSA 2017, supra note 18, at 15; NHTSA 2016, supra note 17, at 25. For now, only the state of California permits violating traffic rules under certain circumstances to reduce the risk. See, CAL. CODE REGS. tit. 13 § 228.06(a)(9) (2018).

144 Bryant Walker Smith, Regulation and the Risk of Inaction, in AUTONOMOUS DRIVING: TECHNICAL, LEGAL AND SOCIAL ASPECTS 571, 582 (Markus Mauer et al. eds., 2015); Jack Stewart, Why People Keep Rear-Ending Self-Driving Cars, WIRED (Oct. 18, 2018, 7:00 AM), https://www.wired.com/story/self-driving-car-crashes-rear-endings-why-charts-statistics/ (quoting Kyle Vogt, the CEO of the leading AV company, who stated that: “We’re not going to make vehicles that break laws just to do things like a human would . . . If drivers are aware of fact that AVs are being lawful, and that’s fundamentally a good
that automated enforcement would be a pivotal tool that can increase compliance via roadway devices—such as speed and red-light cameras—and in-vehicle devices—such as alcohol locks, speed regulators, and proprietary data recorders.\textsuperscript{145} Such enforcement has a great potential to increase compliance, yet there is still no guarantee that human drivers will not break traffic rules. AVs that could violate these rules will not create more accidents because they can be programmed to violate only when necessary in order to prevent more serious risks. Apart from such scenarios, they must be programmed to obey traffic rules.

More importantly, there will be a transition period in which AVs and conventional vehicles evolve together.\textsuperscript{146} There is no reason to think that fatalities caused by human errors will be significantly reduced.\textsuperscript{147} It is therefore of utmost importance that AVs are allowed to violate traffic rules in order to prevent more serious risks posed by human drivers. Some AV developers are already programming their vehicles to adapt to these types of scenarios. For example, the principal engineer of one AV developer stated that they are making AVs more aggressive to fit into traffic flow.\textsuperscript{148} Another AV was programmed to go up to 10 mph above the speed limit in case traffic conditions require.\textsuperscript{149}
Regarding state regulations, most states expect an AV to comply with applicable federal laws and regulations and the traffic and motor vehicle safety laws of a given state before testing or operation.\textsuperscript{150} First, current FMVSSs do not assess the safety of AVs and may restrict the development of AVs.\textsuperscript{151} States have neither the authority nor the budget to create new FMVSSs for AV technology, which again shows the urgency for federal regulation.\textsuperscript{5}\textsuperscript{2}

\begin{itemize}
\item CAL. CODE REGS. tit. 13, § 228.06(a)(9) (2018);
\item CONN. GEN. STAT. ANN. § 13a–260(d)(3) (2019);
\item D.C. CODE ANN. § 50–2352(3) (2013);
\item FLA. CODE ANN. § 319.145(1)(a)(b) (2019);
\item IOWA CODE ANN. § 321.515(1)(b)(c) (2019);
\item LA. REV. STAT. ANN. § 32:400.3(A) (2019);
\item NEB. REV. STAT. ANN. § 60–3303(2) (2018);
\item NEV. REV. STAT. ANN. 482A.080(3) (2017);
\item N.H. REV. STAT. ANN. § 242:1(III)(b)(8)(A)(B) (2021);
\item UTAH CODE ANN. § 41-26-103(1)(a)(b) (2022);
\item The Illinois Executive Order, supra note 28, (II)(2) at 3; The Massachusetts Memorandum, supra note 39, 5(a)(b)(d) at 3; ALA. CODE § 32–9B–3(1)(3) (2019);
\item 2017 N.Y. A9508B Section 1(a) (2020);
\item The Illinois Executive Order, supra note 28, (II)(2) at 3;
\item The Massachusetts Memorandum, supra note 39, 5(a)(b)(d) at 3;
\item COLO. REV. STAT § 42-4-242(1) (2017);
\item FLA. CODE ANN. § 319.145(1)(a)(b) (2019);
\item GA. CODE ANN. § 40–8–11(a)(1) (2018);
\item IOWA CODE ANN. § 321.515(1)(b)(c) (2019);
\item MICH. COMP. LAWS ANN. § 257.665b(1)(c)(d) (2016);
\item NEB. REV. STAT. ANN. § 60–3302(2) (2018);
\item N.H. REV. STAT. ANN. § 242:1(IX)(b)(c) (2021);
\item N.C. GEN. STAT. ANN. § 20–401(b)(1) (2017);
\item N.D. CENT. CODE ANN. § 39–01–01.2(2) (2019);
\item TENN. CODE ANN. § 55–30–103(1) (2017);
\item TEX. TRANSP. CODE ANN. § 545.454(b)(1)(3) (2017), UTAH CODE ANN. § 41–26–103(1)(a)(b) (2022);
\item The Ohio Executive Order, supra note 41, at (3)(g) (4); The Washington State Executive Order, supra note 125, at 3; ARIZ. REV. STAT. § 28–9602(A) (2021).
\item See, e.g., Anita Kim et al., U.S. DEP’T OF TRANSP. & JOHN A. VOLPE NAT’L TRANSP. SYS. CTR., Review of Federal Motor Vehicle Safety Standards (FMVSS) for Automated Vehicles: Identifying Potential Barriers and Challenges for the Certification of Automated Vehicles Using Existing FMVSS, at viii (2016), (“Current Federal Motor Vehicle Safety Standards (FMVSS) do not explicitly address automated vehicle technology and often assume the presence of a human driver. As a result, existing language may create certification challenges for manufacturers of automated vehicles that choose to pursue certain vehicle concepts.”).
\end{itemize}


\textsuperscript{152} However, according to Texas’s recent legislation, AVs are not subject to motor vehicle equipment laws or regulations of Texas that govern motor vehicle operation by a human driver and are not related to ADS. Tex. Transp. Code § 547.618 (2019). This provision is problematic because AVs fall within the definition of motor vehicles, and thus, must conform with current FMVSS that are designed for human drivers. See 49 U.S.C. § 30115(a). It is highly unlikely that an AV developer complies with federal standards and could still be exempted from laws or regulations of Texas related to human drivers at the same time. However, an AV developer could request an exemption from certain FMVSS on many grounds, and as a result, could be granted such an exemption. See 49 U.S.C. § 30113 and 49 U.S.C. § 30114. In this case, there is no barrier for an AV developer to be exempted from state regulations. Unlike Texas, Californian legislators enacted an optimal regulation. This regulation would exempt AVs that are not capable of operating with a human driver or occupant in the vehicle from certain standards of motor vehicles or would enact specific standards for these vehicles only if those exemptions or alternative standards comply with related federal laws or regulations. See S.B. 570 (Cal. 2021).
Second, the requisite of compliance with the state’s traffic rules is related to the performance of AVs and falls under federal authority. Plus, as argued above, AVs will face unpredictable scenarios in which compliance with traffic rules could create more risks. In such cases, rules may need to be violated in order to prevent harm or an accident from happening. Only the state of California allows rules and regulations to be violated to enhance the safety of occupants and/or other road users, which is another example of inconsistent regulation among states. Other states should follow California’s lead on regulation and the Guidance’s suggestions, and permit violations of traffic rules by AVs in emergency situations in order to prevent increased harm.

D. System Safety

The safety of AVs is essential for public acceptance. The NHTSA has recently recalled Tesla’s Level 2 vehicles because the vehicle system called “Full Self Driving” was found to potentially violate local traffic laws and customs when performing many specific driving maneuvers, including adapting vehicle speed in speed zones. Cruise’s Level 4 vehicles disrupted traffic flow and fire rescue operations due to unplanned stops. These examples could raise significant concerns about AV safety among the public. In order to convince the public to

use AVs widely, regulators must ensure that AVs should operate much safer than human-controlled conventional vehicles.\footnote{See Peng Liu et al., \textit{How Safe Is Safe Enough for Self-Driving Vehicles?}, 39(2) RISK ANALYSIS 315 (2019).}

Before allowing the operation of AVs on public roads, assurance is needed that these vehicles will operate safely in a controlled, well-defined, and well-understood manner.\footnote{See EXEC. OFF. OF THE PRESIDENT, THE NATIONAL ARTIFICIAL INTELLIGENCE RESEARCH AND DEVELOPMENT STRATEGIC PLAN 3 (2016).} Another critical aspect of AV safety is to design AVs that are well prepared for any internal malfunctions or failures. To successfully navigate such technical problems, the Guidance proposes that manufacturers and other entities achieve a robust design and validation process based on a systems-engineering approach with the aim of designing AV systems without any unreasonable safety risks.\footnote{NHTSA 2017, \textit{supra} note 18, at 5; NHTSA 2016, \textit{supra} note 17, at 20.} More importantly, the Guidance recommends that this process should pay significant attention to software development, verification and validation, complemented by thorough and measurable software testing.\footnote{Id.} Another notable recommendation is that this process should describe design redundancies, and safety strategies to deal with AV system malfunctions.\footnote{Id.} The Guidance encourages entities to follow voluntary standards issued by standards organizations as well as best practices from other industries.\footnote{Id.}

The Guidance aims to provide flexibility for AV developers by recommending relatively broad practices and designs. However, this points to the lack of specific measures. There are already tools and practices that AV developers can employ. Safety modeling based on the Safety Impact Methodology (SIM) would be an optimal practice for AV developers to assess the safety impacts of their vehicles.\footnote{See SCOTT SMITH ET AL., VOLPE NAT’L TRANSP. RES. CENTER, U.S. DEP’T TRANSP., BENEFITS ESTIMATION FRAMEWORK FOR AUTOMATED VEHICLE OPERATIONS 5 (2015), https://rosap.ntl.bts.gov/view/dot/4298/dot_4298_DS1.pdf.} The SIM employs historical crash, driver performance, and system performance data to provide a rigorous comparison of baseline and treatment vehicle crash conflicts and has been used before to evaluate vehicle-to-vehicle...
AI oversight systems should be required for operational AI systems, including AVs, so that they can comply with the law, react to potential risks, and ensure that operational systems do not unduly depart from the guidelines of their programmers—and bring them back into compliance if they depart. AV developers should be mandated to use several crash typologies in order to prepare for distinct crash types and scenarios, which is especially vital in the transition period in which AVs and conventional human-operated vehicles will operate together.

Lastly, the NHTSA might consider promulgating performance standards that mandate failure mitigation strategies and mechanisms that allow an AV to fail either safely or operationally in the case of a critical failure.

Related to the system safety, the California requires manufacturers to offer software updates at least annually or when AV system changes occur, when required by regulation. Related to this requirement, California also mandates continual updates of location and mapping information by the manufacturer. This regulation also requires notifying the official owner of the AV with instructions on how to access updates when they become available.

AV technology continually interacts with dynamic objects on the roads, such as work zones, road changes, accidents, and potholes that may create difficulties for AVs to navigate. These updates take advantage of new technology that enables manufacturers to fix bugs wirelessly and increase the capability and security of the AV system without requiring a traditional recall.

Plus, traffic laws or regulations of a state are always subject to change, which requires an update. Moreover, each city has its own driving behavior and culture, which represent complex challenges for

---

168 See NHTSA, Framework for Testable Cases and Scenarios, supra note 107, at 93.
170 Id. at § 228.06(a)(9)(B).
171 Id. at § 228.06(a)(9)(C).
AV developers. For example, AVs, particularly trucks equipped with Level 4 or 5 ADS, travel across different states. The software of such AVs may be trained according to the traffic laws of the home state for the vehicle. In this case, the software should be updated when it passes a state border after it detects through GPS signals. Also, over-the-air (OTA) software updates are expected to play a crucial role in the cybersecurity of AVs, as indicated below in detail. This requirement has only been adopted by the state of California, but compulsory updates should be adopted by all other states. This inconsistency between states is yet another risk that a “patchwork” problem will arise.

E. Validation Methods

Before the deployment and testing of AVs on public roads, previous tests and validation methods are necessary to ensure safe, reliable and predictable operation. The Guidance, therefore, recommends developing tests and validation methods that establish a high level of safety, which may include a combination of simulation, test track, and on-road testing. These tests are vital to show that an AV can perform the required behavioral competencies, avoid crash situations, and execute fallback strategies related to its ODD. Since on-road testing cannot be expected to cover every conceivable traffic scenario, such as crash avoidance and failure response scenarios, the Guidance justifies testing of novel scenarios of interest in controlled environments—

---

172 For example, Bryan Salesky, who was the CEO of ARGO AI, explained these differences: Take Pittsburgh, for example. They have the “Pittsburgh Left” turn. This means that the first person who is turning left is often allowed to turn in front of oncoming traffic once the light changes. This means the software needs to change for different geographic locations based on driving culture. Miami is particularly difficult because of the way pedestrians and other motorists behave. They’re not rule followers. This makes it a great learning environment. In Detroit, we have potholes and lane markings that are not very clear. In Washington, D.C., the traffic lanes change hour-by-hour sometimes. Leslie J. Allen, Argo CEO Says Robotaxis Are Still ‘Far Away,' AUTO. NEWS EUROPE (Sep. 24, 2019, 02:55 AM), https://europe.autonews.com/automakers/argo-ceo-says-robotaxis-are-still-far-away [https://perma.cc/6W6H-YVDR].

173 See infra III, F.


175 NHTSA 2017, supra note 18, at 9; NHTSA 2016, supra note 17, at 31.
including simulations,\textsuperscript{176} track, hardware-in-the-loop (HIL),\textsuperscript{177} or software-in-the-loop\textsuperscript{178} environments—to be later integrated into software updates.\textsuperscript{179} In parallel with these suggestions, some states require AV manufacturers to test AVs beforehand under controlled conditions or in a simulation in certain states.\textsuperscript{180}

The Guidance predicts that performance-based safety standards could require manufacturers to deploy test methods—for example, sophisticated obstacle-course-based test regimes sufficiently robust to certify that AVs are capable of safely handling everyday driving scenarios and unusual and unpredictable scenarios.\textsuperscript{181} Further, the Guidance suggests that such standards should consider factors such as weather, traffic, roadway conditions within a particular system’s ODD, as well as the immediate, inevitable and unpredictable actions of other road users.\textsuperscript{182}

However, since tests assessing safety or compliance with FMVSSs must be capable of generating identical results every time the same test is repeated,\textsuperscript{183} the NHTSA acknowledges the difficulties of satisfying reliability on the ground that creating complex and variable test environments that represent all possible real world scenarios would not duplicate each other.\textsuperscript{184} Moreover, a standardized path could incentivize manufacturers to program their vehicles to pass only performance tests without relying on the true capabilities of sensors and algorithms; thus, an objective criterion could be amended or clarified to give the NHTSA the authority to diversify its test procedures.\textsuperscript{185}

\textsuperscript{176} Driving simulator tests enable artificial driving scenarios, repeatable tests, and hazardous traffic scenarios to be tested with different subjects. Thomas Winkle, Development and Approval of Automated Vehicles: Considerations of Technical, Legal, and Economic Risks, in AUTONOMOUS DRIVING: TECHNICAL, LEGAL AND SOCIAL ASPECTS, supra note 31, at 589, 612.

\textsuperscript{177} Once a hardware prototype, such as an ECU, is ready, HIL tests are utilized by placing the prototype in a loop—a software simulated virtual environment—to mirror the real environment as much as possible. Id. at 604–05.

\textsuperscript{178} Unlike HIL, Software-in-the-Loop (SIL) does not utilize particular hardware, and SIL tests must be performed before HIL. The designed model of the software is converted to the code in a manner that could be understood for the target hardware, and this code is executed on the development computer with the simulated model, rather than running on the target hardware as HIL. Id. at 605.

\textsuperscript{179} NHTSA 2018, supra note 23, at 38.

\textsuperscript{180} CAL. CODE REGS. tit. 13 § 227.18(b) (2023); N.H. REV. STAT. ANN. § 242:1(III)(b)(8)(C) (2023); THE PENNSYLVANIA GUIDANCE, supra note 39, at 3.

\textsuperscript{181} NHTSA 2018, supra note 23, at 7.

\textsuperscript{182} Id.

\textsuperscript{183} Chrysler Corp. v. Dep’t of Transp., 472 F.2d 659, 676 (6th Cir. 1972).

\textsuperscript{184} NHTSA 2016, supra note 17, at 77.

\textsuperscript{185} Id. at 78.
There are also specific methods and practices that would be useful for AV developers and the NHTSA. In one report, the NHTSA identified 24 non-exhaustive, test frameworks for AVs under seven generic categories, including, *inter alia*, automated highway drive, low speed shuttle, and valet parking. The NHTSA may also use different methods for different aspects of AVs, depending on what is being tested. For example, if some ODDs—such as urban environments, hill crests, and weather—are difficult to create in test facilities, then the NHTSA should consider on-road testing. Therefore, performance standards should include as many testing techniques that have its own advantages and disadvantages and offer a comprehensive assessment framework.

There are still technical challenges in front of AV technology. Thus, specific methods and validation methods continue to develop. It is of particular importance that a thorough development concept proceed in parallel with the state of the art in the field, and employ interdisciplinary networking groups, including, without limitation, product safety, functional safety, product analysis, and legal services. Further research is indeed necessary to establish specific methods and best practices. The NHTSA is conducting researches on alternative metrics and safety assessment tools that would detect the methods, metrics, and tools to evaluate whether AVs are capable of performing safely and preventing accidents or other incidents related to system performance and behavior related to the ODD and the OEDR capabilities.

---

186 NHTSA, *Framework for Testable Cases and Scenarios*, supra note 107, at ii.
187 *Id.* at 41.
188 *Id.* at 80.
189 See, *e.g.*, MARJORY S. BLUMENTHAL ET AL., RAND CORP., SAFE ENOUGH: APPROACHES TO ASSESSING ACCEPTABLE SAFETY FOR AUTOMATED VEHICLES, at vii (2020) ("Automated vehicles . . . are not coming as quickly as was forecast five years ago—partly because the people developing them now have a clearer understanding of how difficult it is to make them safe . . ."); Rob Stumpf, WHERE ARE ALL THE ROBOTAXIS WE WERE PROMISED? WELL . . ., THE DRIVE (Mar. 1, 2022), https://www.thedrive.com/tech/43439/where-the-hell-are-the-robotaxis-we-were-promised [https://perma.cc/654R-PECK] ("One of the most challenging problems for these vehicles to solve today is figuring out how vehicles can continue to remain driverless in poor weather conditions, even with complex sensor stacks.").
190 Winkle, *supra* note 176, at 608.
191 For example, a research team from the NHTSA presented the advanced testing tools for assessing AVs in a closed-course setting. HEATH ALBRECHT ET AL., NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., U.S. DEP’T OF TRANSP., DOT HS 813 083, ADVANCED TEST TOOLS FOR ADAS AND ADS 39 (2021), https://rosap.nt.bts.gov/view/dot/55991. The
Because of the technical challenges AV technology is facing, we could implement a safety framework for ensuring the safety of AV technology instead of standards that may require specific designs.\textsuperscript{192} In fact, a research team from the RAND Corporation developed a framework that "looks across the settings associated with AV development and demonstration (simulation, closed courses, and public roads) and deployment (on public roads)."\textsuperscript{193} The framework demonstrates measurement possible in each setting—simulation, closed courses, and public roads with and without a safety driver—at each stage (development, demonstration, and deployment).\textsuperscript{194}

It seems that the NHTSA intends to adopt a governmental safety framework specifically designed for AVs that would use performance-oriented approaches and metrics, which in turn would provide the design flexibility for AV developers.\textsuperscript{195} This proposed framework includes a variety of actions by the NHTSA, including guidance documents addressing best industry practices, providing information to consumers, and more formal regulation.\textsuperscript{196} If this proposed framework is enacted as a rule, it will definitely be a historical milestone in the regulation of AVs. This is because such a step would show that the NHTSA's policy departed from how existing FMVSS could effectively be applied to AVs—mostly addressing design aspects of AVs—to how the NHTSA's regulatory authority could be used to evaluate the safety of these vehicles, thus addressing performance aspects of this new technology.

\section*{F. New Standards for Cybersecurity in AVs}

\begin{flushleft}research team engaged with a detailed literature review of difficult real-world driving situations and used possible scenarios that AVs will likely face and need to safely respond, culminating in hardware specifications—namely guided soft targets, drop-in kit, surrogate pedestrian apparatus, and drive-by-wire kit. \textit{Id.}
\end{flushleft}

\textsuperscript{192} In the same vein, to assure safe AVs, the UK has adopted a framework called "safety by design" that becomes part of a new regime of standards, certification, and inspection. Centre for Data Ethics and Innovation, \textit{Responsible Innovation in Self-Driving Vehicles}, 2022, at 16, (UK).


\textsuperscript{194} \textit{Id.} at ix. Specifically, this framework uses leading measurements and lagging measurements. Leading measurements are proxy measures of driving behaviors connected to safety outcomes. Leading measurements encompass i) infractions, i.e. failures to comply with traffic rules, ii) roadmanship, i.e. an integrated measure of driving capability, iii) disengagements, i.e. situations when a person has to take over the control of the AV from ADS. Lagging measurements are real safety outcomes including harm and contain accidents, loss of property, injuries, deaths, and the like.


\textsuperscript{196} \textit{Id.}
We will face new kinds of cyber, terrorist, and ransomware attacks against both AVs and conventional modern vehicles in the future due to increased connectivity in these vehicles via Bluetooth, the internet, and digital algorithms.\textsuperscript{197} AVs will be more susceptible to these risks because they will rely to a greater extent on algorithms and connectivity. No one can guarantee that these vehicles will be free from these risks.\textsuperscript{198} One estimate is that cyber attacks have cost roughly three trillion dollars in lost productivity through 2020.\textsuperscript{199} It is of the utmost importance that AVs are adequately protected against cyber attacks before they occur, have the capacity to immediately detect them when they do arise, and mitigate any damage after they occur.

Even some conventional automakers have been sued for using computer systems that made conventional vehicles susceptible to being hacked by third parties.\textsuperscript{200} The Court, however, rejected this claim on the ground that none of the plaintiffs had been hacked, and that the mere risk of hacking was too speculative to prove that an actual injury exists.\textsuperscript{201}

The Guidance offers valuable recommendations and specifically suggests implementing "a solid product development process" based on a systems-engineering approach in order to reduce risks posed by cybersecurity threats.\textsuperscript{202} The Guidance also advises that all AV actions—including changes, design choices, analyses associated testing, and data—should be traced within a competent document version control environment,\textsuperscript{203} which may be used to detect a source of a cyber attack. Furthermore, the Guidance encourages entities to establish "robust cyber incident response plans" and use a systems-engineering approach


\textsuperscript{198} See, e.g., INST. OF ENG’G & TECH., AUTOMOTIVE CYBER SECURITY: AN IET/KTN THOUGHT LEADERSHIP REVIEW OF RISK PERSPECTIVES FOR CONNECTED VEHICLES 6 (2014), https://www.theiet.org/media/10449/automotive-cyber-security.pdf [https://perma.cc/7ZYY-ZU4H] ("[N]o connected computer system is 100 percent guaranteed secure in terms of invulnerability or the integrity of the data it holds or processes . . . ").


\textsuperscript{200} Cahen v. Toyota Motor Corp., 147 F. Supp. 3d 955, 958 (N.D. Cal. 2015).

\textsuperscript{201} Id.


\textsuperscript{203} NHTSA 2017, supra note 18, at 11; NHTSA 2016, supra note 17, at 21.
that considers vehicle cybersecurity in the design process and adopts a coordinated vulnerability reporting/disclosure policy. The Guidance promotes appropriate investments by states in the digital infrastructure that supports AVs to reduce potential cybersecurity threats. However, the U.S. DoT is aware that further research is necessary in this evolving area. For now, it recommends following established guidance, best practices, and design principles issued by National Institute for Standards and Technology (NIST), the NHTSA, the SAE International, the Alliance of Automobile Manufacturers, Automotive Information Sharing and Analysis Center (Auto-ISAC), and other relevant organizations for vehicle systems.

The Guidance provides valuable suggestions to mitigate cyber threats which can be adopted by entities and states. However, the Guidance’s suggestion to follow established guidelines and best practices lacks specificity that law should provide. These guidelines and

---

204 NHTSA 2017, supra note 18, at 11; NHTSA 2018, supra note 23, at 17.
206 NHTSA 2017, supra note 18, at 11; NHTSA 2016, supra note 17, at 21.
207 NHTSA 2020, supra note 17, at 23; NHTSA 2018, supra note 23, at 32; NHTSA 2017, supra note 18, at 11; NHTSA 2016, supra note 17, at 21. For such voluntary standards, see, e.g., Soc’y of Auto. Eng’rs, SAE Standard J3061: Cybersecurity Guide Article for Cyber–Physical Vehicle Systems, at 1(2016), https://www.sae.org/standards/content/j3061/ (describing a standard on cybersecurity that provides guidance on flexible, pragmatic, and adaptable best practices, including a complete lifecycle process framework and basic guiding principles); Nat’l Inst. of Standards & Tech., Framework for Improving Critical Infrastructure Cybersecurity Version 1.1, at 7–8 (2018), https://nvlpubs.nist.gov/nistpubs/CSWP/NIST.CSWP.04162018.pdf (establishing a cybersecurity risk framework for voluntary use to help entities identify, assess, and manage cyber risks, and the core of this framework consists of five layers: (i) identify: an organizational knowledge to control cybersecurity risk is developed; (ii) protect: suitable protections to assure delivery of critical services are implemented; (iii) detect: suitable activities to recognize the occurrence of a likelihood event are implemented; (iv) respond: suitable activities to take action against an identified cybersecurity incident are implemented; and (v) recover: suitable activities to sustain plans for resilience and to restore impaired capabilities or services); ISO 26262–1:2018 Road Vehicles – Functional Safety, Int’l Org. for Standardization, (Feb. 21, 2020), https://www.iso.org/standard/68383.html [https://perma.cc/NKS6-LDQB] (describing a standard to be applied to safety–related systems installed with one or more electrical and/or electronic systems in series production road vehicles).

best practices mostly do not provide specific technical solutions and leave entities to determine and how to apply the guidelines and practices for their products.\(^{209}\) Companies may adapt voluntary practices according to their needs simply because they are not mandatory.\(^{210}\) Also, voluntary standards and best practices pertaining to cybersecurity are written broadly for conventional vehicles, and thus, would not be technically suitable for AVs given the distinct aspects of the technology.\(^{211}\) Lastly, many guidelines released by different organizations that recommend divergent practices may have the potential to cause confusion in the industry.\(^{212}\)

Instead, it would be optimal to impose flexible, neutral, performance standards as much as technological feasibility allows. For example, preventing cybersecurity threats requires a continuing duty that could be satisfied by entities through an OTA update or prompt notification since these entities design AVs and have detailed knowledge about the prevention of these threats.\(^{213}\) Specifically, OTA updates can remedy software vulnerabilities effectively and economically without requiring traditional safety recalls that impose financial and time burdens on consumers and automakers.\(^{214}\) This is because OTA updates enable the installation of updates in numerous

---

\(^{209}\) See, e.g., AUTO. INFO. SHARING AND ANALYSIS CTR., AUTOMOTIVE CYBERSECURITY BEST PRACTICES: EXECUTIVE SUMMARY 12 (2019), http://www.sovereign-plc.co.uk/sites/default/files/Auto%20ISAC%20Cyber%20Security%20Best%20Practices%20Executive%20Summary.pdf [https://perma.cc/4DRQ-2JNN] (stating that suggested practices are not intended to mandate anyone to take specific action or measures because of each stakeholder's unique needs and capabilities).

\(^{210}\) See, e.g., NAT'L INST. OF STANDARDS & TECH., supra note 207, at vi. ("The decision about how to apply it is left to the implementing organization.").


vehicles simultaneously and increase the repair rate because a physical connection to repair is not required.215

IHS Automotive predicts that automakers will save $35 billion from OTA updates in 2022, significantly rising from $2.7 billion in 2015.216 This is highly likely to happen because many auto companies have utilized OTA updates in recent years. GM utilized OTA updates to patch the software in its millions of vehicles that had cybersecurity vulnerabilities detected by some researchers at the University of California at San Diego and the University of Washington.217 Tesla used OTA updates to fix its 29,222 vehicles, to change the suspension settings that may enhance the performance of its cars.218 BMW used an OTA update to patch a security flaw that could have enabled hackers to unlock the doors of nearly 2.2 million vehicles.219 When using OTA updates, AV developers should consider cybersecurity issues and take all measures explained below to prevent hackings that could take the vehicle’s control or acquire the driver’s personal information.220 That the NHTSA has required Tesla to use an OTA update for improving defects in the recent recall of the manufacturer’s Level 2 vehicles221 is a vital sign that the Agency will frequently use this tool in the future.

The valuable experience we have acquired in technologies such as IT and telecommunications, aviation, and financial payments dictates that cybersecurity is a life-cycle process.222 This is of such significance

---

215 Id. at 15–16.
220 See also RUSSELL BIELAWSKI ET AL., U.S. DEP’T OF TRANSP. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., REPORT NO. DOT HS 812 807, CYBERSECURITY OF FIRMWARE UPDATES 1 (2020), https://www.nhtsa.gov/sites/nhtsa.gov/files/documents/cybersecurity_of_firmware_updates_oct2020.pdf (“While the threats with respect to an OTA update procedure with cybersecurity vulnerabilities are daunting, there is a need to understand software update techniques, the potential threats, as well as potential countermeasures.”).
221 NHTSA Tesla Recall, supra note 156, at 4.
222 CHARLIE MCCARTHY ET AL., U.S. DEP’T OF TRANSP. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., REPORT NO. DOT HS 812 075, A SUMMARY OF CYBERSECURITY BEST PRACTICES
that manufacturers may not have enough incentives to cope with cybersecurity threats, detect cybersecurity vulnerabilities or fix them via software updates for a full life time. In the same vein, the principles of cybersecurity for AVs issued by the UK Department for Transport recommends lifetime product aftercare for the security of software through safe and secure updates.

On the other hand, robustness and reliability of the code operating on AVs are likely to become a pivotal concern vis-à-vis occupants’ physical safety. Minimum levels of encryption requirements, segmenting protocols, and layering systems may be enforced in order to ensure basic protection. A layered approach considers that all entry points into a vehicle would be vulnerable and could lead manufacturers to strengthen AVs’ electrical architecture against cyber attacks and to ensure AV systems revert to safe states after

28–29

223 Mulligan & Bamberger, supra note 214, at 16 (arguing that leaving private companies to cope with cybersecurity threats would not be the right decision in the future on the basis that their incentives could not generate optimal security decisions and encompass the range of public values caused by security risk management).


225 See CHARLIE MILLER & CHRIS VALASEK, IOACTIVE, ADVENTURES IN AUTOMOTIVE NETWORKS AND CONTROL UNITS 4 (2014), https://ioactive.com/pdfs/IOActive_Adventures_in_Automotive_Networks_and_Control_Units.pdf; Pierre Kleberger et al., Security Aspects of the In–Vehicle Network in the Connected Car, 2011 IEEE INTELLIGENT VEHICLES SYMP. (IV) 528, 528 (“The internal as well as external communication must be properly secured.”).

226 Caleb Kennedy, New Threats to Vehicle Safety: How Cybersecurity Policy Will Shape the Future of Autonomous Vehicles, 23 MICH. TELECOMMS. & TECH. L. REV. 343, 349 (2017) (also warning that these laws may be written in broad terms so that malicious attackers will not know the specific obstacles that they need to overcome); U.S. DEP’T OF TRANSP. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., REPORT NO. DOT HS 812 333, CYBERSECURITY BEST PRACTICES FOR MODERN VEHICLES 10–20 (2016), https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812333_cybersecurityformodervehicles.pdf (hereinafter NHTSA, CYBERSECURITY BEST PRACTICES); Derrick Dominic et al., Risk Assessment for Cooperative Automated Driving, 2016 CPS–SPC ‘16: PROC. 2ND ACM WORKSHOP ON CYBER–PHYSICAL SYS. SEC. & PRIVACY 47, 56 (“Authentication and encryption are paramount considerations for the communications of any production AD system and infrastructure.”)).
a successful attack.\textsuperscript{227} Thus, a layered approach lessens the probability of a cyber attack and the consequences of unauthorized access.\textsuperscript{228} AV developers should utilize good security coding practices and deploy tools that enhance security outcomes, such as encryption that could prevent the unauthorized recovery and analysis of firmware.\textsuperscript{229} Some kind of encryption, for example the usage of certificates as used on the Internet, may be used against cyberthreats.\textsuperscript{230}

A comprehensive and systematic approach is an obvious need to design layered cybersecurity protections, including risk–based prioritized identification and protection, timely detection and rapid response, and design in methods and measures.\textsuperscript{231} A holistic approach employs particular countermeasures implemented in layers to establish an aggregated and a risk–based security posture.\textsuperscript{232}

There are many particular measures on the table. Software developers have considerable access to ECUs, which could be exploited by an unauthorized third–party access. Therefore, such access should be limited or eliminated in the absence of any foreseeable operational reason.\textsuperscript{233} Any key or password should be safeguarded from disclosure, as they can enable unauthorized access to vehicle computing platforms.\textsuperscript{234} Diagnostic features should be confined to a particular mode of an AV’s operation as much as possible—such as restricting brakes to operate only at low speeds to prevent disabling them—and diagnostic operations should be designed to eliminate or minimize possible negative consequences in case they are misused or abused.\textsuperscript{235}

The ability to modify malware could be restricted so that it would make more demanding for malware to be installed on AVs, such as the use of digital signing techniques and firmware updating


\textsuperscript{228} NHTSA, CYBERSECURITY BEST PRACTICES, supra note 226, at 10.

\textsuperscript{229} Id. at 18.


\textsuperscript{231} NHTSA, CYBERSECURITY BEST PRACTICES, supra note 226, at 10.


\textsuperscript{233} NHTSA, CYBERSECURITY BEST PRACTICES, supra note 226, at 17.

\textsuperscript{234} Id.

\textsuperscript{235} Id.
systems.236 The use of network services on ECUs would be restricted to essential functionality only, and services operating on these ports should be safeguarded to prevent unauthorized use.237 Safety signals should not be sent as messages on common data buses; instead dedicated inputs from critical sensors could be provided for an ECU, or critical safety information should be conveyed on communication buses separated from any ECUs with external network interfaces.238 Since it is foreseeable that an AV can connect to a cellular wireless network, the industry should design features that could enable changes in network routing rules to be immediately propagated and applied to the vehicle, or all vehicles.239

A cybersecurity simulator that the FAA has been developing could be adapted by the AV industry to identify vulnerabilities and risk mitigation strategies, also known as a “white hat hacking.”240 The FAA uses the Airborne Network Simulator System (ANSS) to detect vulnerabilities in a controlled environment and assess potential consequences.241 Another suggestion is to implement Common Vulnerability Scoring System calculator to assess cybersecurity vulnerabilities based on monitoring or protection mechanisms, the broadness of damaged locations, and the hazard of drivers, passengers, or pedestrian lives.242

Systems that are critical to the safe operation of AVs, such as brakes and the throttle, could be required to run separately from infotainment systems, thereby confining the reach of cyber threats that can penetrate the car’s systems.243 Processors, vehicle networks, and external connections should be separated through logical and physical isolation techniques in order to confine and manage pathways that could

236 Id. at 18.
237 Id. at 19.
238 Id.
239 Id. at 20.
240 See NHTSA, 2014 REPORT ON CYBERSECURITY BEST PRACTICES, supra note 222, at 30. The FAA uses the Airborne Network Simulator System (ANSS) to detect vulnerabilities in a controlled environment and assess potential consequences; Id. at 8.
241 Id.
243 Chasel Lee, Grabbing the Wheel Early: Moving Forward on Cybersecurity and Privacy Protections for Driverless Cars, 69 FED. COMM’NS L. J. 25, 49 (2017); Onishi, supra note 242, at 389. But see Tom Simonite, Your Future Self-Driving Car Will Be Way More Hackable, MIT TECH. REV. (Jan. 26, 2016), https://www.technologyreview.com/2016/01/26/163604/your-future-self-driving-car-will-be-way-more-hackable/ (reporting that a computer science professor argues that it is not possible to isolate the important parts, such as brakes, because each part must be connected to enable many functions, allow repairs and software upgrades).
be exploited by attackers. Potential entry points through which attackers may penetrate the vehicle’s systems also include Wi-Fi, Bluetooth, GPS Receiver, USB Port, CD/DVD player.

Some incidents clearly showed that critical safety systems should be segmented from infotainment systems. A researcher designed an article-sized gadget that exploited an authentication flaw in a remote link app, then enabling a hacker to unlock doors, honk the horn, start the ignition, and accessing all the personal information. Another successful hacking happened through the app embedded in the vehicle. Thus, since it is predictable that aftermarket devices, such as insurance dongles and personal equipment, such as cell-phones, will be connected with AV systems through Bluetooth, USB and the like, AV developers and manufacturers of aftermarket devices and equipment should implement strong and reasonable cybersecurity protections for their products.

An open-source approach could be implemented into AV software to prevent future hackings and also provide transparency in terms of how algorithms function. Also, open robotics has the potential to lead to rapid innovation and growth as computers open to programming modifications promoted the success of personal computing.

Antivirus software in the AV software should also be required for AV developers. A virus or malware should be detected within a

244 NHTSA, CYBERSECURITY BEST PRACTICES, supra note 226, at 19.
248 NHTSA, CYBERSECURITY BEST PRACTICES, supra note 226, at 20-21.
249 An open source licensing denies anyone the right to exclusively exploit software, and thus, allows creators to reach a broad audience. ANDREW M. ST. LAURENT, UNDERSTANDING OPEN SOURCE & FREE SOFTWARE LICENSING 4 (Simon St. Laurent ed., 2004).
250’ UK Principles for Cybersecurity, supra note 224, at 13 (recommending adopting open design practices, using peer-reviewed code where possible, and sharing source code where appropriate).
vehicle, or should be trapped within a limited vehicle area. For example, one company is developing an anti-hacking software that can block spurious code at the time of intrusion, thereby preventing the entry of a code that is inconsistent with the factory settings. If virus or malware invades reaches safety-critical areas, the driver should be informed immediately, or minimum fail-tolerance operations should be performed, such as braking, stopping engines, in case safety-critical areas are infected.

Vehicle data could be stored remotely in cloud systems, thus deterring attackers from acquiring such personal data.

Criminal aspects of carjacking, hacking, or unauthorized intrusions into AVs should be addressed explicitly in the criminal codes. A question related to this proposal arises whether existing state computer crime laws would apply to cyber attacks against AVs. Since AVs are not defined as "computers" according to these statutes, they are not within the scope of computer crime laws. At the federal level, the Computer Fraud and Abuse Act (CFAA) would be another option to punish cyber attacks against AVs equipped with ECUs that can be classified as a computer. Although unauthorized intrusions via an AV's ECU would constitute a violation of the CFAA, its application to AVs will not be entirely clear. This is because an operation of an AV equipped with ECUs would not always meet the definition of a "protected computer" according to the CFAA that requires such a computer to be employed in or have an effect on interstate or foreign commerce. Therefore, a criminal statute specifically tailored for hacking AVs is needed in the future.

---

253 Onishi, supra note 242, at 388–89.
255 Onishi, supra note 242, at 388–89.
256 See also UK Principles for Cybersecurity, supra note 224, at 14 (recommending that data should be stored, transmitted, and controlled securely; and that personally identifiable data that is sent to other systems should be sanitized where possible).
257 Goodrich, supra note 72, at 286.
258 Lee, supra note 243, at 41.
259 Computer Fraud and Abuse Act, 18 U.S.C. § 1030 ("Whoever . . . having knowingly accessed a computer without authorization or exceeding authorized access . . . shall be punished . . . ").
260 Lee, supra note 243, at 50.
Once a cyber attack occurs, rapid detection and remediation capabilities should be made available in AVs, such as mitigating the safety risk to occupants and other road users or transitioning to a reasonable risk state.262 A last-resort layer of preventive security could be made available to occupants or drivers of AVs who may prefer to disengage the vehicle when other security measures fail against a cyber attack.263 This feature would not necessarily be the safest choice, for example in cases where hackers targeted to disable the vehicle engine.264 Yet, it could be used efficiently in cases where AVs were accelerated unnecessarily, refused to stop, or tried to navigate to an undesired location.265 While taking all these measures, privacy concerns should not be neglected.266

The NHTSA prefers a voluntary guidance for cybersecurity measures, which is similar to the UK’s approach.267 It may be true that cybersecurity standards for both AVs and conventional vehicles are currently under development.268 However, past experience tells us that leadership from the federal government drives industry-specific standards as a minimum security requirement, such as occurred with

262 NHTSA, Cybersecurity Best Practices, supra note 226, at 12.
263 Kennedy, supra note 226, at 348.
264 Id.
265 Id.
266 See PATRICK PYPE ET AL., AUTOMATED DRIVING: SAFER AND MORE EFFICIENT FUTURE DRIVING 17-27 (Daniel Watzenig & Martin Horn eds., 2017).
267 See UK Principles for Cybersecurity, supra note 224 (informing that the UK created principles of cybersecurity for AVs, which are (i) organizational security at board level; (ii) appropriate and proportionate management and assessment of security risks; (iii) a lifetime product aftercare and incident response by organizations; (iv) the co-operation between sub-contractors, suppliers, and potential third parties; (v) systems should incorporate a defense-in-depth approach; (vi) a lifetime management of the security of all software; (vii) a secure and controlled transmission and storage of data; and (viii) being resilient to attack and responding proportionately in case of the failure of sensor or defenses).
financial payments. Thus, the U.S. DoT should not be hesitant to replicate the measures mentioned above as a FMVSS on cybersecurity for AVs in the future. As the U.S. DoT stated that: 'In the area of cybersecurity, both our research and public comments indicate that there are no widely used automotive industry standards... The agency believes that there is a role for robust standards to assess cybersecurity risks, associated safety hazards, and mitigation priorities for automotive electronics.

New standards should be flexible, neutral and performance-oriented so that they can keep pace with new technologies and standards. OEMs that produce sensors, maps or teleoperation services for AVs should also be subjected to these requirements. For example, the financial payment industry developed the Payment Card Industry Security Standards, and mandates all entities in the payment-processing system to comply with these standards. The importance of cybersecurity protection in original equipment is evident in today’s conventional vehicles. For example, a successful hack achieved through exploiting the on-board diagnostics that insurance companies utilize in order to monitor speed and location.

---

269 NHTSA, 2014 REPORT ON CYBERSECURITY BEST PRACTICES, supra note 222, at 19.
270 See, e.g., CHANNON, supra note 212, at 53 ("[A]t least prior to the introduction of more advanced autonomous vehicles, global requirements are necessary."); Lee, supra note 243, at 49 (proposing a “preventive medicine” approach for a cybersecurity regulation in which manufacturers proactively shield AVs’ systems and design mechanisms to self-diagnose potential problems).
272 See, e.g., The Secretary of the UN Task Force on Cyber Security and Over-the-air Issues, Draft Recommendation on Cyber Security of the Task Force on Cyber Security and Over-the-air Issues of UNECE WP.29 GRVA, U.N. Doc. GRVA-01-17, para. 7.1.2. at 11 (2018) (“Specifying technical solutions would be inappropriate as these would not stand the test of time and would stifle innovation and competition.”).
273 See also CORRADO BORDONALI ET AL., SHIFTING GEARS IN CYBER SECURITY FOR CONNECTED CARS, MCKINSEY & COMPANY (2017), https://www.mckinsey.com/-/media/mckinsey/industries/automotive%20and%20assembly/our%20insights/shifting%20gears%20in%20cybersecurity%20for%20connected%20cars/shifting-gears-in-cyber-security-for-connected-cars.pdf [https://perma.cc/DLY9-X9GB ] ("OEMs... need to ensure that security practices are consistently implemented within the full value chain (i.e., including suppliers.").
Even though new flexible, neutral and performance-oriented standards are enacted, the U.S. DoT may inspect cybersecurity plans submitted by manufacturers in order to determine their compliance with the required elements.\textsuperscript{276} Despite the unsuccessful attempts in the past,\textsuperscript{277} new Congressional action could also produce specific legislation covering AV cybersecurity or, alternatively, implement cybersecurity provisions in a piece of general AV legislation.\textsuperscript{278}

G. Data Sharing on Cybersecurity

The Guidance shrewdly promotes manufacturers' sharing data related to cybersecurity on the basis that no entity should need to experience the same cyber vulnerabilities in order to learn from "past mistakes."\textsuperscript{279} The Guidance recommends that manufacturers should make a summary of their cybersecurity plan publicly available,\textsuperscript{280} thereby enhancing public trust and confidence in AVs.

As argued below, voluntary sharing of data would not be achievable by entities who may not be willing to share their most valuable asset but instead prefer to promote the safety of their vehicles.\textsuperscript{281} However, since cyber, ransomware, and terrorist attacks pose a serious threat to public safety, voluntary and anonymous sharing data related to cybersecurity should be readily adopted by entities with

\textsuperscript{276} See, e.g., AV START Act, S. 1885, 115\textsuperscript{th} Cong. § 14(a), at § 30101(b)(3) (2017) (assigning the Secretary to inspect any cybersecurity plan submitted by a manufacturer).


\textsuperscript{278} See, e.g., Security and Privacy in Your Car Act of 2019, S. 2182, 116\textsuperscript{th} Cong. (2019).

\textsuperscript{279} NHTSA 2016, supra note 17, at 21-2; see also Exec. Order No. 13691, 80 Fed. Reg. 9347 (Feb. 20, 2015) (promoting the voluntary formation of organizations that share information related to cybersecurity risks and incidents in order to respond to them as soon as possible); Exec. Order No. 13636, 78 Fed. Reg. 11737 (Feb. 12, 2013) (assigning the Attorney General, the Secretary of Homeland Security, and the Director of National Intelligence to ensure the timely production of unclassified reports of cyber threats and to disseminate these reports to a targeted private sector entity, thereby enabling such entity to protect and defend themselves better).

\textsuperscript{280} See also AV START Act, S. 1885 § 14(a).

\textsuperscript{281} See infra IX, C.
the federal guidance. Specifically, voluntary and anonymous information sharing in the aviation industry could be successfully extended to the automotive industry.

The Guidance, therefore, proposes that transportation–related cyber vulnerabilities and exploits could be disclosed to government partners anonymously via ISACs. These ISACs create a centralized organization that increases the ability of the industry to prepare for, respond to, and recover from cyber threats, vulnerabilities, and incidents. Specifically, Auto–ISAC was established in August 2015 by Auto Alliance, Global Automakers and some OEMs and launched an intelligence–sharing portal in January 2016. Moreover, the Guidance explicitly encourages transportation sector entities to contact the National Cybersecurity and Communications Integration Center which is a 24–7 cyber situational awareness, incident response, and management center that is considered to be the federal government’s cyber communications hub. The U.S. DoT could also initiate another collaboration, including among AV manufacturers, to establish a coordinated vulnerability disclosure policy where a newly discovered vulnerability is shared between manufacturers, thereafter enabling them to discover and mitigate cybersecurity risks.

H. California’s Approach to Safety and Cybersecurity


284 NHTSA 2018, supra note 23, at 17.


287 NHTSA 2018, supra note 23, at 17.

California has enacted provisions that require manufacturers to disclose safety–related and cybersecurity-related information. California holds a pioneering position in this respect. For example, manufacturers are required to certify that an AV has satisfied "appropriate and applicable current industry standards" to protect against, notify, and respond to cyber attacks, illegal intrusion, or false vehicle control commands. California also requires manufacturers to show certification showing the relevant tests, method validations have been carried out, and proof that vehicles are safe for deployment on public roads based on the results of tests and validations.

California also requires manufacturers to describe how a vehicle satisfies the standards of Level 4 or 5 vehicles, to submit a summary of testing results of an AV in ODD, including the overall number of miles driven on public roads, test tracks, or other private roads, testing methods for validating the performance of AVs, the number of collisions that occurred when AVs were in autonomous mode.

These requirements impose ex–ante and ex–post duties on AV developers in California, yet remain too vague to address safety and security aspects of AV technology. For example, the regulation does not specify "appropriate and applicable current industry standards" for cybersecurity or the relevant tests and method validations and leaves each entity to determine itself what these are. The result, of course, is the likely development of different practices in the industry and harmonization problems in the future. As proposed above, there are many available specific solutions for cybersecurity threats and safety, such as OTA software updates, encryption requirements, layering systems, SIM, hazard and risk assessment.

For mandatory testing results, it is strikingly similar to pre–market safety assurance tools as proposed above and would show that

---

289 CAL. CODE REGS. tit. 13, § 228.06(a)(10); THE PENNSYLVANIA GUIDANCE, supra note 39, n.3 (explaining that in the same vein, the state of Pennsylvania requires that the tester must also take reasonable measures to deal with cybersecurity risk, including industry standards, best standards, company policies, or other means).

290 CAL. CODE REGS. tit. 13, § 228.06(a)(11); id. § 228.12 (stating that a manufacturer must report a safety-related defect that poses an unreasonable risk to the safety of AVs as soon as it is found).

291 Id. § 228.06(c)(2); ARK. CODE ANN. § 27–51–2002 (explaining that in the same vein, the state of Arkansas requires manufacturers to provide a description of how a fully autonomous vehicle has the capability to be operated without seat belts, a steering wheel, or a rearview mirror).

292 Id. § 228.06(c)(7).

293 Id. § 228.06(c)(7)(A).

294 Id. § 228.06(c)(7)(B).

295 Id. § 228.06(c)(7)(C).
AV developers engaged with testing and conducted testing methods, thereby providing transparency and trust. However, these requirements do not impose any specific measures, practices or designs, but merely mandate what a manufacturer has done so far before being allowed to test or operate its vehicles on public roads.

In the absence of federal regulation, California has implemented requirements related to the performance of AVs. Again, although they are too vague, these cybersecurity and safety requirements have the potential to trespass the authority of the U.S. DoT in the future.

V. A HUMAN DRIVER AND LICENSING REQUIREMENTS FOR AVs

An AV equipped with a Level 4 or 5 ADS does not need human intervention. However, current motor vehicle and traffic laws require that a motor vehicle can be operated on public roads only by a natural person who holds a valid driver’s license. The U.S. DoT suggests states evaluate their current laws and regulations that may pose an unnecessary impediment to the safe testing, deployment, and operation of AVs, and modify requirements designed for a human driver as appropriate. In order to comply with state traffic laws that apply to drivers of conventional motor vehicles—speed limits, traffic signs—, the policy leaves States to accept an AV system (especially SAE Levels 3–5) as the “driver” that performs the driving task and monitors the driving environment. Thus, states need to decide whether a human driver and licensing requirement should apply to these AVs.

Some states have enacted a provision stating that no motor vehicle laws or traffic laws must be understood to (i) require a licensed human driver; or (ii) prohibit the AV system from operating in a fully autonomous manner. Accordingly, some states recognize the AV

---

296 NHTSA 2018, supra note 23, at 18; NHTSA 2017, supra note 18, at 19; NHTSA 2016, supra note 17, at 39.
297 NHTSA 2017, supra note 18, at 21; NHTSA 2016, supra note 17, at 39.
298 See also Brock, supra note 128, at 777 (“The first step in explicitly ‘legalizing’ self-driving cars at the state level is to begin introducing more concise, technology-friendly language to code definitions of ‘driver’.”).
system as the operator or driver of the vehicle in assessing whether it complies with applicable traffic or motor vehicle laws.\textsuperscript{300}

The State of Tennessee further recognizes the ADS as a "person" which means 'a natural person, firm, copartnership, association, corporation, or an engaged ADS.'\textsuperscript{301} This legislation would simply mean that an AV should be treated as a person to meet the "person" requirement. Even though it is not related to this regulation, an AV as a subject raises a highly contentious philosophical question. For example, does an ADS possess skills that are enough to accept them a person, e.g. free intent, consciousness, and autonomy? Assuming that the ADS possesses those skills, there are still sociological barriers in front of AI systems or robots to be accepted as equal agents in society. Therefore, there is still a long way before accepting the ADS as a legal person, and it should not be legislated without seeking a consensus or fundamental baseline on the technical, philosophical, and sociological issues.\textsuperscript{302}

Human driver and licensing requirements must be modified to include AVs. Otherwise, manufacturers will struggle to satisfy statutes and regulations that contain human driver and licensing requirements, which would be used by defendants to prove non-compliance with statutes and regulations. For Level 4 and 5 vehicles, the Guidance does not see the need for licensed human drivers despite Level 4 vehicles’ limited operation in certain environments or under certain conditions, which makes the distinction noticeably clear in comparison with lower level vehicles.\textsuperscript{303} States should, therefore, exempt users of Level 4 and 5 vehicles from licensing requirements because they will not play any role in the driving task. A few states recognized this need and did not impose licensing requirements for such AVs.\textsuperscript{304} People with disabilities are the first social group that will benefit from this exemption.

\textsuperscript{300} FLA. STAT. ANN. §316.85(3)(a) (2022); MICH. COMP. LAWS ANN. § 257.665b(4) and § 257.665(s) (2022); TENN. CODE ANN. §§ 55–8–101(19)(b), 55–8–101(47)(b), 55–12–102(10)(c) and 55–30–106(b) (2021); UTAH CODE ANN. §§ 41–1a–102(49)(a), 41–1a–102(49)(b), 41–6a–102(47), § 41–26–102.1(22) and 41–26–104(1)(a) (2022); ARIZ. REV. STAT. § 28-9602(E) (2021).


\textsuperscript{302} See also Kyle Colonna, Autonomous Cars and Tort Liability, 4 CASE W. RES. J. L. TECH. & INTERNET 81, 103–4 (2012) ("Neither hardware nor software falls within the lay definition of a human being . . . Even if the software is so advanced that it can 'think' like a human, neither hardware nor software possesses a human being's mental capacity, physical attributes, knowledge, or age . . . ").

\textsuperscript{303} NHTSA 2017, supra note 18, at 24; NHTSA 2016, supra note 17, at 43–4.

\textsuperscript{304} See, e.g., N.D. CENT. CODE ANN. § 39–01–01.2(4) (2019) (stating that since a natural person occupying an autonomous vehicle does not drive or resume control of the
Conversely, since users may play a crucial role in controlling Level 3 vehicles when interventions are requested, these users should still be required to have a driver’s license to operate them. The Guidance explains that licensed drivers are still necessary to perform the driving functions for Levels 3 vehicles and have the responsibility to be promptly available to execute the driving task upon a request or when the automated system disengages. States, however, should design new licenses for Level 3 vehicles in order to ensure proper human/machine interaction and should consider the requisites for training and testing for users to obtain a Level 3 driver’s license.

VI. TELEOPERATION SYSTEM

Some experts believe that fully AVs that perceive the environment perfectly cannot be designed in the short-term. They propose instead the utilization of “teleoperation” in which the user can push a button to call for help from remote human backup, which can intervene when an AV confronts complicated conditions. For example, if an AV detects a complicated situation that it cannot handle, it will stop and ping its control center where a human operator would look around the car via its cameras and sensors and send new instructions. These instructions could be, say, to drop the passengers off immediately in a particular spot, or to take specific immediate actions to prevent a possible accident. Another startup company has developed a solution using cellular networks to maintain a strong connection between the car and its human passenger. The company is planning to establish call centers in which remote human operators monitor its AVs closely and

autonomous vehicle, he or she is exempted from licensing requirements); TENN. CODE ANN. § 55-50-304(8) (2021) (stating that a person operating an automated-driving-system-operated vehicle is also exempted from licensing).

305 NHTSA 2018, supra note 23, at 40; NHTSA 2017, supra note 18, at 24; NHTSA 2016, supra note 17, at 43.

306 Alex Davies, Nissan’s Path to Self-Driving Cars? Humans in Call Centers, WIRED (May 1, 2017, 7:00 PM), https://www.wired.com/2017/01/nissans-self-driving-teleoperation/ [https://perma.cc/L7AM-JUX3] (reporting that other companies were granted patents on teleoperation).

307 Id.

308 Id.

309 Alex Davies, Self Driving Cars Have a Secret Weapon: Remote Control, WIRED (Jan. 2, 2018, 7:00 AM), https://www.wired.com/story/phantom-teleops/ [https://perma.cc/A8U3-FH33]; see also Jack Stewart, Sweden’s Electric Robo-Truck is Made for Life in the Forest, WIRED (July 12, 2018, 04:00 AM), https://www.wired.com/story/einride-t-log-electric-autonomous-self-driving-truck/ [https://perma.cc/LB8K-UN7T] (reporting that a Swedish startup is building self-driving trucks that can be controlled by a remote operator).
are ready to take control of the car in the case of an emergency. The human operators would be able to guide the car’s controls remotely from the center and relinquish control when everything returns to be normal.

In fact, the Guidance foresees a need for a remote driver or remote operation in the future. It defines him or her as a driver who is not physically seated in a position to manually exercise in-vehicle braking, accelerating, steering, and transmission gear selection, yet is still able to operate the vehicle. The Guidance, however, fails to provide reasonable suggestions on the operation of remote operators in terms of their training, responsibility and the like.

On the other hand, some states that require teleoperation systems for AVs have provided specific requirements for these systems and thus predictability for AV developers. Therefore, some states define teleoperation system as hardware built into the vehicle enabling a remote human operator to monitor and perform some or all of the DDT. “Remote operator” in such a system means a natural person who can communicate with occupants of an AV via a communication link and more importantly, can execute the DDT or take control of the vehicle to achieve a minimal risk condition. Some states require this remote operator to have a driver’s license to control, monitor, and engage with the vehicle. Some state regulation states that this remote operator is deemed to be the operator of the vehicle and subject to

---

310 Davies, supra note 306.


312 NHTSA 2018, supra note 23, at 46.

313 SAE 2021, supra note 67, at 19 (stating that in the same vein, the SAE defined “remote driving” as “real-time performance of a part or all of the DDT and/or DDT fallback . . . by a remote driver” in its most-cited J3016 standard; the SAE did not use the term “teleoperation” to avoid confusion because it claims that the term is not defined consistently in the literature); see ALA. CODE § 32–9B–1(9) (2019); FLA. STAT. ANN. § 316.003(89) (2022); LA. REV. STAT. ANN. § 32:400.1(10) (2019).

314 ALA. CODE § 32–9B–1(8) (2021); CAL. CODE REGS.Tit. 13, § 227.02(n) (2022); FLA. STAT. ANN. § 316.003(89)(2020); LA. REV. STAT. ANN. § 32:400.1(9) (2021); UTAH CODE ANN. § 41–26–102.1(27)(2022); THE MASSACHUSETTS MEMORANDUM, supra note 42, 1(w); ARK. CODE ANN. § 27-51-2001(10) (2019). Similarly, the SAE standard defines a remote driver as “a driver who is not seated in a position to manually exercise in-vehicle braking, accelerating, steering, and transmission gear selection input devices (if any), but is able to operate the vehicle.” SAE 2021, supra note 67, at 21.

315 ALA. CODE § 32–9B–6(c) (2021); CAL. CODE REGS. tit. 13, § 227.02(n) (2022); FLA. STAT. 316.003(89)(2020); LA. REV. STAT. ANN. § 32:400.6(B) (2021); ARK. CODE ANN. § 27-51-2004(b) (2019).
States' Approaches to Autonomous Vehicle Technology

Some states require manufacturers to equip an AV to provide the location and status of the AV and to allow two-way communication between occupants and the remote operator in case of technical failures that risk the safety of the vehicle, the occupants, or other road users.\textsuperscript{317} This technology would evolve as a standard in the future—such as seatbelts or airbags—or will not be needed if manufacturers design a Level 4 and 5 vehicle that is safe and reliable. Unlike an ordinary licensed driver for conventional vehicles, remote drivers will need advanced technology to be able to control an AV, and they will supervise many vehicles at the same time. Thus, remote drivers' responsibilities should be clarified by federal policymakers. Apart from that, it appears that teleoperation systems will increase public acceptance—at least to some extent—during the transition period when consumers may be hesitant to use AVs.

VII. AUTONOMOUS VEHICLE NETWORKS

It seems likely that companies that have spent significant resources developing the technology will recoup their investment by deploying autonomous vehicle test networks.\textsuperscript{318} For example, an AV company sought the help of remote operators several times in a test ride when a Level 4 vehicle got stuck in the traffic. See JJ Ricks Studios, Waymo Self-Driving Taxi Fumbles In Construction Zone, Blocks Traffic | JJ Ricks Rides With Waymo # 54, YOUTUBE (May 13, 2021), https://www.youtube.com/watch?v=zdKCQKBvH-A [https://perma.cc/2GSF-ZX4V]; see also Andrew J. Hawkins, Domino’s Teams Up With Nuro for Driverless Pizza Delivery in Houston, THE VERGE (Jun. 17, 2019, 11:06 AM), https://www.theverge.com/2019/6/17/18681891/dominos-nuro-driverless-pizza-delivery-houston [https://perma.cc/ZQ32-PFSA] (informing that an AV manufacturer that designs AVs that deliver groceries are chasing its vehicles with human drivers and are using remote technology to monitor each vehicle).
AVs as a part of ride-share fleets. Therefore, some states have developed relevant definitions—an “autonomous vehicle network company” or “on-demand autonomous vehicle network” is a transportation service that connects a passenger to a fully autonomous vehicle via a software application or other digital means. These networks may offer transportation for hire, public transportation, or transportation for multiple passengers.

Further, some states require that only Level 4 and 5 vehicles can be used by autonomous vehicle network companies. The reason for such a restriction is that some passengers—including inexperienced, inattentive, or intoxicated persons or people with disabilities—are placed in a difficult position if a Level 3 vehicle, as a part of AV networks, requests their intervention. Excluding vehicles equipped with a Level 3 automated driving system, promoting on-demand autonomous vehicle networks is a logical policy because future customers would be better off so long as they are not required to intervene to operate a vehicle upon request.


320 NEV. REV. STAT. § 706B.030 (2017); NEV. REV. STAT. § 706B.160 (2016); FLA. STAT. § 316.003(49) (2020); UTAH CODE ANN. § 41-26-102.1(21) (West 2022); MICH. COMP. LAWS. § 257.2b(8) (2022); ARIZ. REV. STAT. ANN. § 28-9701(1) (2021). Other states include within this definition the transport of goods. IOWA CODE § 321.514(6)(2020); IOWA CODE § 321.518(2020); N.H. REV. STAT. ANN. § 242:1(II)(h)(2021); N.D. CENT. CODE § 8-12-01(3) (2019); NEB. REV. STAT. § 60-3301(8)(2022).


322 NEV. REV. STAT. § 706B.170(1)(2017); UTAH CODE ANN. § 41-26-102.1(21)(West 2022); NEB. REV. STAT. § 60-3305(1)(2022); ARIZ. REV. STAT. ANN. § 28-9701(1)(2021) (only mentioning fully AVs).
Furthermore, some states explicitly state that on-demand autonomous vehicle network is governed by the same laws that govern the operation of transportation network companies, but excluding the rules that reasonably apply to a human driver only.323 Given its potentially wide deployment in the future, the state of Nevada requires an AV network company to inspect each fully autonomous vehicle before deploying it in a transportation service and at least once each year after that.324 This approach makes these rules consistent with Level 4 and 5 vehicles that operate without any human operator physically present in the vehicle.325 Excluding Level 4 and 5 vehicles from the rules that are originally created for a human driver of transportation network should be also adapted by other states who allow the operation of an autonomous vehicle network, as it would be vulnerable to be attacked by defendants who could raise an argument that the company violates the statute.

The AV industry is expected to use a ride-share business model in order to recoup the significant investments that have been made in AV technology. However, only a few states have regulated AV vehicle networks, and requirements are not consistent. Those that have not regulated AV vehicle networks also cause ambiguity regarding whether existing laws governing transportation network companies apply for fleets that include AVs. A patchwork of state laws is once again, the main issue that needs to be resolved in the future.

VIII. STATUTORY DUTIES RELATED TO POST-CRASH, TRANSPORTING CHILDREN, SEAT BELTS IN THE ERA OF AVs

A. Post–Crash Duties

323 FLA. STAT. § 316.85(2020); UTAH CODE ANN. § 41-26-106(1)(West 2022); ARIZ. REV. STAT. ANN. § 28-9704. (2021) For the rules that apply to a human driver, see, e.g., UTAH CODE ANN. § 13-51-106 (2015) (imposing duties on a transportation network company to implement a policy prohibiting that a transportation network driver may not use a drug or alcohol or be under the influence such substances during the operation of a prearranged ride).


325 See also UTAH CODE ANN. § 41-26-106(2) (West 2022) (stipulating that state laws including rules specifically designed for human drivers will not apply to the operation of a vehicle engaged with a Level 4 or 5 automated driving system that is a part of an on-demand autonomous vehicle network); FLA. STAT. ANN. § 316.85(4) (West 2020); UTAH CODE ANN. § 13-51-102(5)(b) (West 2022) (stating that a Level 4 or 5 automated driving system is included under the term "transportation network driver").
Even if every reasonable measure is taken to maximize safety, AVs inevitably will be involved in accidents—whether at fault or not. The Guidance recommends that entities should design a documented process for how an AV is restored to service after being engaged in an accident.\textsuperscript{326} The Guidance rightly suggests that the vehicle should not be permitted to operate in AV mode when sensors or critical safety control systems are impaired, and the vehicle should be brought to a minimal risk condition upon diagnosis of a problem.\textsuperscript{327} The Guidance recommends that AV developers consider when designing these vehicles how first responders and public safety officials will interact with AVs during emergencies.\textsuperscript{328}

The Guidance, however, is silent on the specific behavior that AVs should undertake after an accident. The vagueness of the guidelines will create more uncertainties because each AV developer’s design would generate different behavior, which will be unpredictable for road users, first responders, and public safety officials.

On the other hand, states traditionally impose duties on drivers involved in accidents. The question arises whether these duties apply to accidents involving an AV without a human driver physically present. To answer this question, it is necessary to describe such duties and their scope. The duties imposed on the driver of a vehicle involved in an accident that culminates in the injury or death of any person or damage to property include stopping the vehicle at the scene.\textsuperscript{329} The driver must also remove the vehicle immediately from the traveled portion of the roadway when involved in an accident culminating in damage to a vehicle.\textsuperscript{330} Such duties may also encompass (i) providing the driver’s name and address and the registration number of the vehicle; (ii) providing reasonable assistance to any injured person; or (iii) ensuring that emergency services and local law enforcement are contacted and request an assistance if the person who is unconscious, appears deceased or is unable to communicate.\textsuperscript{331}

\textsuperscript{326} NHTSA 2017, supra note 18, at 13; NHTSA 2016, supra note 17, at 25.
\textsuperscript{327} NHTSA 2016, supra note 17, at 25.
\textsuperscript{328} NHTSA 2018, supra note 23, at 33.
Since these duties are obviously designed for human drivers who can readily satisfy a wide range of duties, the need arises to address post-crash duties for AVs that are trained only to perform the driving task. Therefore, some states require "manufacturers" to report to law enforcement officials any collision resulting in property damage, bodily injury or death to law enforcement officials. Some states deem these duties to be satisfied if a fully AV does not leave the scene of the accident, and the vehicle itself, the operator, the owner, or the remote operator immediately contacts a local law enforcement agency and provides all relevant information after the accident. By this modification, these states adapt statutory duties following an accident and allow flexibility for AVs to satisfy such duties. Users of Level 3 vehicles, however, may still be subject to current post-crash duties because there is a human driver who is capable of exercising them.

Several states rightly sought to modify statutory duties for AVs, yet other states did not do so, which creates a patchwork of state laws for AV developers. However, although such regulation seems appropriate at the present time, it would also fall within the performance aspects of AVs that the NHTSA regulates. This is because certain post-crash behaviors can only be achieved by testing and validating the behavioral competency of AVs. Therefore, the specific behavior that is generally expected from AVs after a crash could be standardized.
through an FMVSS that requires the programming and training of vehicles to behave as expected. In the future, this will also shift the traditional balance of federal and state powers.

B. Duties on Persons Transporting a Child

Existing law imposes a duty on parents, guardians or other human persons transporting a child in a motor vehicle, e.g., using a child-restraint system. Whether or not these duties will apply to AVs should be answered simply because Level 4 and 5 vehicles will offer mobility for children in the future. Tennessee, Georgia and Arizona have provisions that do not hold the AV system or the owner of the AV responsible for duties imposed on parents, guardians, or other human person accompanying the child. It appears that such duties will continue to apply to parents, guardians, or other human persons accompanying a child in AVs in Tennessee and Georgia.

The state of North Carolina is the frontrunner in legislation addressing children in an AV. The regulation imposes a duty on the parent or a legal guardian to secure one or more occupants who are less than sixteen years old in a child passenger restraint system or seat belt. The legislation also mandates twelve years as the minimum age for unsupervised minors as occupants in a fully AV. It imposes a duty on the parents or a legal guardian of such minors not to knowingly allow such use unless the minor is supervised by a person who is eighteen years old.

334 See, e.g., Tenn. Code Ann. § 55–9–602(a)(1) (2017) (imposing a duty on any person transporting any child who is under one year old or weighs twenty pounds or less to protect the child by properly using a child-restraint system in a rear-facing position); id. § 55–9–602(a)(2) (2017) (imposing a duty on any person transporting any child who is between the ages of one and three and weighs more than twenty pounds to protect the child by effectively using a child passenger restraint system in a forward-facing position); id. § 55–9–602(g)(5)(B)(ii) (2017) (holding the parent or legal guardian of a child liable when no person accompanies the child for breaching the duty imposed on any person transporting any child who is between the ages of nine and twelve and measures four feet nine inches or more in height, in a passenger motor vehicle to protect the child by using a seat belt system; and for a child who is between the ages of thirteen and fifteen years of age, by effectively using a passenger restraint system, including safety belts).


336 N.C. Gen. Stat. § 20–401(c) (2017) with reference to § 20–137.1(a) (2017). The parent or a legal guardian of a minor has a duty to not transport a child in the bed or cargo area of a fully autonomous vehicle that has an open bed or open cargo area without permanent overhead restraining construction. Id. § 20–401(c) (2017) with reference to § 20–135.2B (2017).
years or older. North Carolina’s regulation provides more specificity compared with those of Tennessee and Georgia. However, no states have addressed the situation of children (and car seats from them) travelling alone in Level 4 or 5 vehicles.

Overall, these states adopt a paternalistic approach toward child passengers in AVs and aim to ensure that they are secured in a child-restraint system and travel in the AV safely. For other states, this is still ambiguous and should be resolved via new rules tailored for AVs. All other states should take action on this issue.

C. Duties to Use Seat Belts

Some consumers might be under the impression that AVs will operate safely and can never be involved in an accident—thus possibly producing unsafe consumer behavior. The usage of seat belts is another subject that has been regulated by the states. For example, the state of Tennessee enacted legislation addressing the usage of seat belts in AVs. Neither the operator nor the owner of an AV may be fined for the conduct of any passenger failing to wear a safety belt. Some states explicitly require the passenger or human operator to comply with the seat-belt rule and assign sole responsibility to him or her for any violations. These enacted rules reiterate the essential principle of tort law, which is that each person is responsible for his or her conduct. Yet, it would be better to enact new rules specifically tailored explicitly for AVs.

The NHTSA enacted new rules in FMVSS No. 208 that clarify where and which seat belts must be installed in AVs. First, the NHTSA requires AV manufacturers to install Type 2 belt in two designated seating positions in the front row. This requirement encompasses scenarios where there is a single inboard seat and one or

---

337 *Id.* § 20–401(d) (2017).
340 FMVSS No. 208 mandates that most light vehicles (GVWR less than 4,536 kg (10,000 lb.) must be equipped with a lap/shoulder (Type 2) seat belt assembly in each outboard designated seating position, including the driver’s seat. NHTSA 2022, *supra* note 10, at 18577. This standard allows center seating positions to be equipped with only a lap belt in the subset of light vehicles that have a GVWR of less than 3,855 kg (8,500 lb.) and unloaded weight of 2,495 kg (5,500 lb.). *Id.*
341 *Id.* at 18578.
no outboard seats in the front row of seats. Second, if the front row includes two inboard seats and one outboard seat, the new standard requires that a remaining single outboard seat and one of the inboard seats must be installed with Type 2 belt and that the other inboard seat must be installed with only a lap belt. Third, if the front row includes two inboard seats and no outboard seat, both inboard seats must be equipped with Type 2 belt. For medium sized buses (GVWR or more than 4,536 kg (10,000 lb), but not greater than 11,793 (26,000 lb)) equipped with an ADS, the NHTSA requires that all front seats are required to have a Type 1 or 2 seat belt.

IX. DESIGN REQUIREMENTS RELATED TO DIENGAGEMENT, HUMAN MACHINE INTERFACE, DATA RECORDERS, SOFTWARE UPDATES

A. Disengagement System and Human Machine Interface

A human driver has supervisory role in Level 2 and 3 vehicles that imposes a duty to intervene properly upon a takeover request. However, humans are notoriously bad at maintaining attention for long periods while supervising rare signals though this is exactly what Level 2 and 3 vehicles require drivers to do so. A research found that most drivers engage in complex secondary task activities when provided the opportunity to give the vehicle control the AV system, such as reading,

342 49 C.F.R. § 571.3 (2022)("Outboard designated seating position means a designated seating position where a longitudinal vertical plane tangent to the outboard side of the seat cushion is less than 12 inches from the innermost point on the inside surface of the vehicle at a height between the design H-point and the shoulder reference point (as shown in fig. 1 of Federal Motor Vehicle Safety Standard No. 210) and longitudinally between the front and rear edges of the seat cushion.").

343 Id. Which inboard seat will be installed with Type 2 belt is left to AV manufacturers to decide. Moreover, AV manufacturers could install Type 2 belt to both inboard seats.

344 Id. at 18578. Initially, the NHTSA’s Notice of Proposed Rulemaking (NPRM) proposed that all front passenger seats in medium-sized buses and large buses (GVWR greater than 11,793 kg (26,000 lb)) should be protected with the same level of protection that would apply to the driver of a non-ADS vehicle. Id. However, the NHTSA withdrew the proposed changes to the seat belts required for the front seats in large school buses because the Agency believes that more examination is needed. Id.

345 Id. at 18581. Initially, the NHTSA’s Notice of Proposed Rulemaking (NPRM) proposed that all front passenger seats in medium-sized buses and large buses (GVWR greater than 11,793 kg (26,000 lb)) should be protected with the same level of protection that would apply to the driver of a non-ADS vehicle. Id. However, the NHTSA withdrew the proposed changes to the seat belts required for the front seats in large school buses because the Agency believes that more examination is needed. Id.

texting, reaching an object in the back seat.\textsuperscript{348} As a result, Level 2 and 3 vehicles might cause reduced driver situation awareness.\textsuperscript{349}

Thus, human drivers who do not experience motion sickness while driving might be prone to it because of the lack of controllability in Level 2 and 3 vehicles.\textsuperscript{350} More importantly, since the passive role of supervising an automated system is less satisfactory than the active role of manual control, the reduced workload would be equally hazardous to road safety as overload when automation fails.\textsuperscript{351} For a human driver to assume control takeover takes a few seconds after a vehicle has given the warning, which creates considerable risk if the transition is not successfully achieved or an incident happens in the meantime. Research has demonstrated that this might result from human operators' overreliance and/or trust in the capabilities and limitations of these vehicles.\textsuperscript{352}

Risks related to the reduced workload might occur differently in Level 2 and 3 vehicles. In Level 2 vehicles, although a human driver knows that he or she must monitor the driving environment and the road, misuse could occur when a driver intentionally chooses to engage in a

\begin{itemize}
\item Jamson et al., \textit{supra} note 349.
\item See, e.g., M. Russell Sheldon et al., U.S. DEP’T OF TRANSP. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., \textit{Naturalistic Study of Level 2 Driving Automation Features}, at 3 (2018), \url{https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/documents/812642_naturalistic-study-of-level-2-driving-automation-functions.pdf} ("[P]articipants still had a higher than realistic expectation of function. Trust in the longitudinal system did increase over time . . . "); Myra Blanco et al., U.S. DEP’T OF TRANSP. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., \textit{Human Factors Evaluation of Level 2 and Level 3 Automated Driving Concepts}, at 11 (2015), \url{https://www.nhtsa.gov/sites/nhtsa.dot.gov/files/812182_humanfactorseval-1213-automdrivingconcepts.pdf} ("Overall, participants greatly trusted the capabilities of the automated systems. Although this trust is essential for widespread adoption, participants were also observed prioritizing non-driving activities over the operation of the vehicle and disregarding TORs when they were presented."); Tracy Hresko Pearl, \textit{Hands on the Wheel: A Call for Greater Regulation of Semi–Autonomous Cars}, 93 \textit{IND. L. J.} 713, 715–16 (2018) ("[D]rivers . . . will overestimate the safety of their car's semi–autonomous capabilities while simultaneously underestimating their need to monitor the vehicle . . . A growing body of research shows that drivers have an extremely difficult time adequately monitoring semi–autonomous cars . . . ").
\end{itemize}
secondary task. Conversely, in Level 3 vehicles, since a human driver has enough time to transition from a secondary task to the driving task, the driver’s engagement with the secondary task is not necessarily misuse. Instead, a misuse could occur when the driver neglects warnings/alerts for some reason, even though he or she has fully comprehended.

The U.S. DoT is aware that a human driver may not be able to make an intervention in Level 2 and 3 vehicles—she may not remain alert after becoming disengaged from the driving task. The Guidance, therefore, suggests that AV system communication, at a minimum, should have the capability to inform the human operator or occupant that the AV system is (i) working properly; (ii) presently engaged in automated driving mode; (iii) presently unavailable for automated driving; (iv) experiencing a malfunction; and (v) requesting the operator to intervene.

These indicators and warnings could function as an adequate warning to a human driver of a danger, malfunction, or a request, thus minimizing the risk of an accident and helping to satisfy the manufacturers’ duty to warn. Yet, if the driver is distracted, intoxicated, or inattentive, these indicators and warnings would not be enough.

Recognizing the importance of design, some states have required that safety features be incorporated in this phase. To start with, some states require that manufacturers include an easily accessible mechanism to engage and disengage the AV system and a visual indicator which shows the engagement of the AV system inside the AV’s cabin. Other states require that if a fully AV includes equipment that allows an occupant to perform any aspect of the DDT, that

---

353 Marinik et al., supra note 83, at 20.
354 Id.
355 Id.
356 NHTSA 2018, supra note 23, at 30; NHTSA 2017, supra note 18, at 10; NHTSA 2016, supra note 17, at 22.
357 NHTSA 2016, supra note 17, at 22–23.
358 CAL. CODE REGS. tit. 13, § 228.06(c)(1)(B)(i); D.C. CODE ANN. § 50–2352 (obliging manufacturers to install a manual override into an AV which allows a driver to assume control at any time for operation on a public roadway); NEV. REV. STAT. ANN. § 482A.080(2)(a)(1) (requiring the installation of a means to engage and disengage the AV system which should be easily accessible for Level 3 vehicles); THE PENNSYLVANIA GUIDANCE, supra note 39, 5(g), at 3.
359 CAL. CODE REGS. tit. 13, § 228.06(c)(1)(B)(i) (2008); D.C. CODE ANN. § 50–2352 (West 2013) (obliging manufacturers to install a manual override into an AV which allows a driver to assume control at any time for operation on a public roadway); NEV. REV. STAT. ANN. § 482A.080(2)(a)(1) (West 2013) (requiring the installation of a means to engage and disengage the AV system which should be easily accessible for Level 3 vehicles); THE PENNSYLVANIA GUIDANCE, supra note 39, 5(g), at 3.
equipment must either be stowed or made inoperative in such a manner that an occupant cannot take control of the vehicle during the active operation of the ADS.\textsuperscript{360} The state of Arkansas allows the design of a fully AV that can function solely under automation or, alternatively, a human person is permitted to operate when the ADS is not activated.\textsuperscript{361} Relatively few states require a system that safely alerts a licensed human operator to take control once the AV system fails.\textsuperscript{362}

These design requirements are vague and highly likely to discourage AV manufacturers from producing AVs in different states, as complying with the different design requirements would be a difficult task—for example the requirement to equip a mechanism that enables occupants to perform some DDT in an AV, e.g., engage or disengage the ADS, compared to the requirement to stow such a mechanism or make it inoperative during the operation of the ADS. Future harmonization problems will arise. Manufacturers would prefer uniformity regarding design requirements throughout all U.S. states—a different design for each state would raise manufacturing costs significantly.

The NHTSA's latest regulation will not likely to resolve this inconsistency. Since Level 4 and 5 vehicles do not need a human intervention, manually operated driving controls are not necessary in these vehicles. In order to pave the way for vehicle designs that will not have a driver's seat, a steering wheel and accompanying steering column, or have just one front outboard passenger seating position, the NHTSA enacted new definitions or modified existing terms.\textsuperscript{363} In addition, the Agency modified a requirement\textsuperscript{364} to clarify instead that

\textsuperscript{360} N.C. GEN. STAT. § 20–400(3) (2017).
\textsuperscript{361} ARK. CODE ANN. § 27-51-2001(4) (2019).
\textsuperscript{362} FLA. STAT. § 319.145(2) (2019); NEV. REV. STAT. § 482A.080(2)(a)(3) (2013); THE PENNSYLVANIA GUIDANCE, supra note 39, at 5(f)(3). Florida requires that once such an alert is sent, the AV system must also fulfill a minimal risk condition. FLA. STAT. § 319.145(2) (2019). This regulation is specifically required for Level 3 vehicles and excludes Level 4 and 5 vehicles. Id.\textsuperscript{363} NHTSA 2022, supra note 10, at 18567. These terms and definitions are: i) driver air bag, ii) driver dummy, iii) driver's designated seating position, iv) manually operated driving controls, v) outboard designated seating position, vi) passenger seating position, vii) row, and viii) steering control system. Moreover, the NHTSA modified some terms and definitions that employ the terms "driver's seat" or "steering controls" to afford a spatial reference for where equipment must be installed in the vehicle, or test equipment must be placed in a compliance test. Id. at 18569. Instead, the NHTSA adopted the front row or the front outboard seating position as a reference rather than the driver's seat, and the "left" or "right" side of the vehicle rather than "driver's side" or "passenger side." Id.\textsuperscript{364} The former requirement that was effective until September 26, 2022, was: "Driver's seat. Each vehicle shall have an occupant seat for the driver." 49 C.F.R. § 571.207 (2009).
an AV does not need to have a driver’s seat. These regulatory efforts, however, do not touch upon whether AVs must have an easily accessible mechanism to engage and disengage the AV system or whether a mechanism that allows occupants to perform some DDT must be stowed or made inoperative during the operation of the ADS. Rather, the NHTSA’s regulation removes regulatory barriers for new designs of Level 4 and 5 vehicles. This is an indication that the NHTSA focuses on facilitating design aspects of AVs rather than regulating safety aspects of these vehicles.

On the other hand, the NHTSA’s position on the designs of ADS-equipped dual-mode vehicles provide more specificity. Assuming that these vehicles have the capability of stowing driving controls, the NHTSA requires manufacturers to certify compliance with all applicable FMVSSs in both modes, namely with the manually operated driving controls available and with the controls stowed. When the manually operated driving controls are in active, the vehicle would need to satisfy the FMVSS requirements at that designated seating position as applied to a driver’s designated seating position. When these controls are stowed, the vehicle would need to satisfy the FMVSS requirements at the DSP as applied to a passenger seat. We could deduce from these regulations that ADS-equipped dual-mode vehicles should have a mechanism that can be activated by human users to stow or activate manually driving controls at their request.

More importantly, the NHTSA’s latest regulation does not focus on crucial aspects of human-machine interface in Level 2 and 3 vehicles. Current state regulations merely require a warning mechanism and thus are not adequate to establish optimal and safe interaction between human occupants/drivers/users and AVs. However, defining new roles for humans in Level 2 and 3 vehicles will be vital to ensure that they correspond to the capabilities of the human information processing system and comply with the expectations and needs of human drivers. Thus, in interactions with the ADS, experts deem

---

365 The new requirement explicitly requires only vehicles that have manually operated driving controls to have a driver’s seat. 49 C.F.R. § 571.207 (2022).
366 NHTSA 2022, supra note 10, at 18570.
367 Id.
368 Id.
369 It is likely that only the state of Arkansas’s regulation is compatible with the NHTSA’s regulation for ADS-equipped dual-mode vehicles. See ARK. CODE ANN. § 27-51-2001(4) (2022).
necessary transparent interfaces to be designed according to the human mental system for the situation and system awareness.\textsuperscript{371}

When considering both the Guidance’s suggestions and state regulations, many suggestions about the human-machine interface could be made. There are already active monitoring systems that can efficiently warn users of Level 2 and 3 vehicles.\textsuperscript{372} A monitoring system that actively tracks the driver’s behavior and guides the vehicle to minimize the risk of an accident without any need for human intervention could be a preferable design in the future, along with its warning functions.\textsuperscript{373} Such a warning system might also include haptic mechanisms that alert human operators effectively along with visual and aural mechanisms.\textsuperscript{374} Such monitoring system would be one in which an infrared camera tracks the position of the driver’s head and a green light bar in the steering wheel flashes a warning if it detects that the driver is distracted for more than a few seconds.\textsuperscript{375} Moreover, this system will ring a bell, vibrate the seat, and activate a red light flashing if the driver still neglects the warning.\textsuperscript{376} If the driver still does not take the control, the vehicle will automatically stop and call emergency services.\textsuperscript{377}

Current monitoring systems should be standardized in terms of the means employed for alerts and how long a human driver can be inattentive before they are activated.\textsuperscript{378} This is important because if a user of an AV rents a different type of AV, he or she does not have to learn a new series of alerts, so standardization will help drivers quickly

\begin{thebibliography}{99}
\bibitem{371} Id. at 119.
\bibitem{372} States may also prohibit driver behaviors that cause great risks, such as disabling or interfering with the attentive warning systems as drivers would want to pay less attention to the road deliberately or find these systems annoying. Pearl, supra note 352, at 745.
\bibitem{374} See, e.g., Marco della Cava, \textit{Warning Drivers: Your Car Can Cruise On Its Own, But You’re Still Responsible}, USA TODAY (May 29, 2018, 12:58 PM), https://www.usatoday.com/story/tech/2018/05/29/car-makers-semi-self-driving-car-technology-autopilot-propilot-super-cruise/633789002/ [https://perma.cc/QE66-7TNW] (reporting that Audi and Nissan have implemented visual and aural mechanisms to alert human drivers, and if these drivers are still inattentive, the vehicle will shut down).
\bibitem{375} Alex Davies, \textit{Cadillac’s Self–Driving System May Be the Smartest Yet}, WIRED (June 29, 2017, 08:00 AM), https://www.wired.com/story/cadillac-super-cruise-self-driving-gm/ [https://perma.cc/QVD6-3NZ7].
\bibitem{376} Id.
\bibitem{377} Id.
\bibitem{378} Pearl, supra note 352, at 741–42.
\end{thebibliography}
understand new systems.\textsuperscript{379} Therefore, a new FMVSS should mandate transparent and effective monitoring and warning mechanisms that include haptic, aural, and visual systems.\textsuperscript{380} The NHTSA asserts that there is still a need for additional research on user-interface usability and comprehension for all level vehicles, especially during emergencies.\textsuperscript{381} However, effective monitoring and warning systems already exist. The NHTSA should promulgate performance-based standards for such systems without requiring any specific design. Since the proper human intervention is crucial in Level 2 and 3 vehicles, the inaction of the NHTSA in this regard would lead to many fatalities.

Manufacturers may not have incentives to install such warning mechanisms due to their costs.\textsuperscript{382} If such efficient mechanisms are not mandated, manufacturers will have a strong incentive to blame human drivers. For example, one negligent driver involved in an accident in January 2018 failed to actively steer a Level 2 vehicle for thirteen minutes, which caused the accident.\textsuperscript{383} Although investigators from the National Transportation Safety Board (the NTSB) found that the driver had misused the vehicle, they also recommended the vehicle manufacturer design applications that could more effectively perceive the engagement of the driver and warn one who is inattentive.\textsuperscript{384}

\textsuperscript{379}Id.
\textsuperscript{381}NHTSA 2018, \textit{supra} note 23, at 30–39. The NHTSA maintains its position in its final rule and declines to adopt haptic and audible alerts for AVs, as the Agency believes that more information and research are necessary to implement these alerts that are capable of providing information to occupants without causing confusion. NHTSA 2022, \textit{supra} note 10, at 1857.
\textsuperscript{382}See, e.g., Tim Higgins, \textit{Tesla Considered Adding Eye Tracking and Steering Wheel Sensors to Autopilot System}, \textit{WALL ST. J.} (May 14, 2018, 5:53 PM), \url{https://www.wsj.com/articles/tesla-considered-adding-eye-tracking-and-steering-wheel-sensors-to-autopilot-system-1526302921} [https://perma.cc/G7TJ-V8PF] (reporting that Tesla considered implementing sensors including camera and infrared sensor to track drivers’ eyes or sensors on the steering wheel to monitor drivers’ hands, both were not implemented in Tesla vehicles due to their costs).
A mechanism that safely alerts a human driver must be made available for not only Level 2 and 3 ADS but also Level 4 and 5 driving automated systems. For example, in the accident report released after an autonomous shuttle collided with a truck, NTSB found that the operator could have prevented the accident if he had quick access to the controller. Although Level 4 and 5 systems do not request human intervention, occupants of AVs would prefer to have the opportunity to disengage the AV system in case of a failure in the ADS or an emergency situation. Recognizing this need, the Automated Vehicle Safety Consortium published a voluntary standard for Level 4 and 5 vehicles in which passengers might need to stop or alter the trip due to emergency reasons. However, this option should not extend to all driving controls, as occupants may tend to take control of the vehicle monitoring system is fundamentally weak because it’s easy to cheat and doesn’t monitor very consistently.”.


See Gasser, supra note 103, at 537–38 (arguing that passengers in AVs should always have the possibility to cause the vehicle to stop at the nearest safe and appropriate location); Goodrich, supra note 72, at 287–88 (proposing a disengaging device in an AV which enables the operator to override the subsequent directions, disengage the autonomous system, and cause the vehicle to pull over in case of hacking or technological malfunctions); Douma & Palodichuk, supra note 62, at 1161 (arguing that the disengage option would be a safety measure that enables the operator to take control of a malfunctioning AV).

Automated Vehicle Safety Consortium, AVSC Best Practice for Passenger-Initiated Emergency Trip Interruption AVSC00003202006 (June 2020), https://avsc.sae-itc.org/principle-5-5471WV-45187C7.html?respondentID=26220787%23our-work#Started [https://perma.cc/L9V5-94Q7]. This standard provides two options. First, “Passenger-initiated Emergency stop” (PES) allows passengers who perceive an emergency—such as a medical condition—to push a button, and the PES will always bring the vehicle to a controlled stop. Id. at 6-7. Second, “Passenger-initiated Emergency Call” (PEC) allows passengers who perceive an emergency to communicate with fleet operations, where humans must be available to assess the situation and determine possible necessary actions, such as stopping or rerouting the vehicle. Id. at 7-8.
unnecessarily. This is especially necessary during the transition period when the public may be hesitant to trust AVs.

B. Collecting Data

Collecting data on motor vehicle crashes and incidents through recording devices promises to improve motor vehicle safety significantly because they provide important information for researchers, manufacturers, and regulators to study crash and pre-crash scenarios, and other incidents. For example, the NTSB’s investigations significantly enhanced when such recorders are available to inform what happened. The data collected by the recorder could especially be used to prove other road users’ negligence, a malfunctioning of the system, or any salient defect.

The next significant aspect of data collection is detecting the human-machine interface in Level 2 and 3 vehicles. Due to the foreseeability of proper human intervention issues, the Guidance suggests that AVs should keep data related to the status of the AV system and whether the AV system or the human driver was controlling

---

388 Gasser, supra note 103, at 549. However, this will likely be highly controversial in the future. The Human Driving Association (“The HDA”) will object to AVs without a mechanism that allows a human driver to take full control because the Association is founded to protect people’s right to drive their own cars and freedom of movement. Human Driving Manifesto, THE HUMAN DRIVING ASSOC., http://humandriving.org/manifesto [https://perma.cc/3UJ6-88T8]. The HDA is planning to advocate regulations requiring AV manufacturers to implement a steering wheel in each AV and design AVs that should be fully controllable by humans at all times. M.R. O’Connor, The Fight for the Right to Drive, NEW YORKER (Apr. 30, 2019), https://www.newyorker.com/culture/annals-of-inquiry/the-fight-for-the-right-to-drive?utm_source=NYR_REG_GATE [https://perma.cc/MM6W-DBYU].

389 See Kennedy, supra note 226, at 348–49 (arguing that the presence of a disengagement mechanism would enable occupants to resume some control in an AV which could mitigate public fears and increase the acceptance of AVs); Douma & Palodichuk, supra note 62, at 1161 n.13 (arguing that the justification for disengagement systems is a psychological help for the public who have concerns about giving all control to an AV, and such systems could constitute a political pacifier for people who may not be ready to give up the freedom of driving); Automated Vehicle Safety Consortium, supra note 387 (“Passengers who are provided a degree of control (agency) over their trip in emergency situations should have improved trust in, and therefore acceptance of, ADS-DVs.”).


the vehicle at the time.\textsuperscript{392} Such data will be of critical importance in accidents occurring in Level 2 and 3 vehicles. This is because a human driver could always argue that had the AV properly requested he or she to intervene, the accident would not have happened. A manufacturer could counterargue that the AV, in fact, correctly requested the driver to intervene, but that the driver failed to take control and avoid the accident and, as such, is responsible. Collecting and maintaining the data on the human and machine interface could help to prove each party’s argument. Thus, in Level 2 and 3 vehicles, a data recorder could reveal whether or not a human driver was controlling the vehicle or properly responded to a take-over-request, which could be a decisive factor in determining the liability question.

In fact, event data recorders (EDR) for light vehicles were regulated in order to record valuable data for crash investigations and analysis of safety equipment performance.\textsuperscript{393} However, this regulation is not mandatory, because it only applies to vehicles voluntarily equipped with an EDR and manufactured on or after Sept. 1, 2012.\textsuperscript{394} The NHTSA attempted to change this “if-install” requirement into a new FMVSS mandating the installation of EDRs in 2012, but the Agency withdrew the notice of proposed rulemaking in 2019 on the basis that 99.6 percent of light 2017 motor vehicles already included EDRs that are compatible with the regulation.\textsuperscript{395}

Regarding AVs, the Guidance rightly suggests that manufacturers or other entities should collect event, incident, and crash data to record malfunctions, degradations, and failures that can be used to prove the cause of any such issues.\textsuperscript{396} In addition, the Guidance encourages manufacturers and other entities to collect data related to events resulting in (i) fatalities and personal injuries; or (ii) damage to the vehicle involved that cannot be operated under its own power and therefore requires towing.\textsuperscript{397} The Guidance urges that this data should

\textsuperscript{392} NHTSA 2017, \textit{supra} note 18, at 14; NHTSA 2016, \textit{supra} note 17, at 18.
\textsuperscript{393} Event Data Recorders, 49 C.F.R. § 563.2 (2023).
\textsuperscript{394} 49 C.F.R. § 563.3 (2023).
\textsuperscript{395} Federal Motor Vehicle Safety Standards; Event Data Recorders, 84 Fed. Reg. 2804 (Feb. 8, 2019).
\textsuperscript{396} NHTSA 2017, \textit{supra} note 18, at 14; NHTSA 2016, \textit{supra} note 17, at 17.
\textsuperscript{397} NHTSA 2017, \textit{supra} note 18, at 14; NHTSA 2016, \textit{supra} note 17, at 17–18. The policy also recommends collecting, storing and analyzing data in terms of “positive outcomes,” defined as events where the AV system accurately detects a safety-related situation and successfully escapes an accident—also called near misses and edge cases between AVs and other vehicles, pedestrians and bicyclists. \textit{Id.} at 18. Lastly, the Guidance recommends that AVs should record, at a minimum, all information relevant to the event and the performance of the system so the circumstances of the event can be reconstructed. NHTSA 2017, \textit{supra} note 18, at 14; NHTSA 2016, \textit{supra} note 17, at 18.
be stored, maintained, and made readily available for retrieval by the entity itself and by the NHTSA for crash reconstruction purposes, along with aggregate data probably for use in administrative investigations.

The Guidance’s suggestions are significant, yet their voluntary nature is likely to preclude wide adoption by AV developers. Manufacturers may simply claim that there is no FMVSS requiring them to install data recorders. For example, Tesla sought a court order from its customers who wanted to access to data. Or, the company suggested a $995 service from a third-party vendor to reach the data without a guarantee to capture the events in question. A principal analyst at a research company convincingly proposed that:

“We should not ever have to rely on the manufacturer to translate this sort of data, because they are potentially liable for product defects and they have an inherent conflict of interest . . .”

Thus, the Agency’s justification for delaying a new FMVSS mandating EDRs for conventional vehicles should not apply to AVs. AVs will operate without a human driver, and data recorders are a must—

398 NHTSA 2017, supra note 18, at 14; NHTSA 2016, supra note 17, at 17–18.


400 Ryan Beene, Tesla Crashes Highlight ‘Black Box’ Challenge for Investigations, BLOOMBERG (Jan. 3, 2020, 3:03 PM), https://www.bloomberg.com/news/articles/2020-01-03/tesla-crashes-highlight-black-box-challenge-for-investigations#xj4y7vzkg [https://perma.cc/RP8V-KYQW]. After another accident happened in 2016, Tesla again requested a subpoena even from investigators because of its privacy policy. Jordan Golson, Read The Florida Highway Patrol’s Full Investigation Into The Fatal Tesla Crash, THE VERGE (Feb. 1, 2017, 1:13 PM), https://www.theverge.com/2017/2/1/14458662/tesla-autopilot-crash-accident-florida-fatal-highway-patrol-report [https://perma.cc/M5LA-6AEC]. In the same vein, Ron Hedges, senior counsel at Dentons and former magistrate judge in U.S. District Court for the District of New Jersey, commented about the accessibility of data in AVs involved in an accident for lawyers: I assume a number of these companies will say they have proprietary data, so that is not going to be easy for you to get . . . You’re going to have to go to a court to gain access, and you’re also going to be dealing with confidentiality issues.

have for passengers, road users, researchers and law enforcement to learn what caused an accident.\footnote{See, e.g., Tom Simonite, \textit{Data Shows Google’s Robot Cars Are Smoother, Safer Drivers Than You or I}, MIT TECH. REV. (Oct. 25, 2013), https://www.technologyreview.com/s/520746/data-shows-googles-robot-cars-are-smoother-safer-drivers-than-you-or-i/ [https://perma.cc/ZUF2-WJNE] (reporting that Chris Urmson, who was the head of the self-driving car project at Google, stated that the data AVs collect in order to navigate can provide a powerful and accurate picture of exactly who was responsible in an accident).} For example, states that wisely foresee the functionality of data recorders mandate their installation in AVs in order to record and store (i) sensor data in the seconds before an accident; or (ii) the ADS’s status and vehicle attributes.\footnote{CAL. CODE REGS. tit. 13, § 228.06(a)(6) (2022); CAL. VEH. CODE § 38750(c)(G) (2022) (requiring data minimum thirty seconds before an accident); MICH. COMP. LAWS ANN. § 257.665b(1) (West 2023) (requiring no specific time); TEX. TRANSP. CODE ANN. §§ 545.454(a), 547.615(a)(2) (requiring no specific time, but requiring the data to include (i) the speed and direction the vehicle is traveling; (ii) vehicle location; (iii) steering performance; (iv) brake performance—\textit{e.g.} whether brakes were used before an accident—; and (iv) the driver’s safety belt status, and notifies the accident to a central communications system when the accident happens); THE MASSACHUSETTS MEMORANDUM, supra note 42, 3(s) (requiring data minimum five seconds before a crash); THE PENNSYLVANIA GUIDANCE, supra note 39, 5(i) at 3 (requiring no specific time). This data may be required to be kept in a read-only format and must be accessible and downloadable via a commercially available tool. CAL. CODE REGS. tit. 13, § 228.06(a)(6) (2022); CAL. VEH. CODE § 38750(c)(G) (2022). The State of Michigan requires an automatic crash notification technology. MICH. COMP. LAWS ANN. § 257.665b(1) (West 2023). This technology is defined as a vehicle service that combines wireless communications and vehicle location technology to determine the need for or to facilitate emergency medical response in case of an accident involving the vehicle. \textit{Id.} § 257.2b(4). Lastly, data recorders should not be limited to sensor data but also must record and store how algorithms decided to react before an accident.} Relatively few states have mandated data recorders without addressing privacy considerations, and this patchwork of state laws could hamper the broad adoption of AVs in the future.

Therefore, the NHTSA should enact a new FMVSS that mandates the installation of data recorders for AVs specifically.\footnote{The NHTSA could mandate AV developers send reports including the circumstances and potential causes of crashes and incidents involving AVs. NHTSA 2016, supra note 17, at 81. Yet, these reports only involve one manufacturer and could not mandate other manufacturers if their vehicles are not involved in any accidents or incidents.} This data will be essential to litigation resulting from accidents involving AVs. Both plaintiffs and defendants can use this data to make a case for the other’s negligence or a defective product.\footnote{See, e.g., Jeffery Mackowski, \textit{Good but Not Great: Autonomous Vehicles and the Law in Florida}, 11 FIU L. REV. 221, 240 (2015) (arguing that data recorders would be used to determine whether a person could have been able to utilize a disengaging mechanism and prevent a criminal act); Gasser, supra note 103, at 546 (arguing that recording vehicle
comprehensible and accessible explanations for how they made decisions will also warrant the trust of potential customers. The reliability of data retrieved from these recorders should be guaranteed, and privacy settings should be transparently communicated with users regarding who owns the data. In order to overcome the reliability and privacy concerns, the data should remain only in the vehicle, and transparency could be required.

C. Sharing Data

Data is crucial for training machine-learning algorithms, which improve when introduced to more complex and complicated scenarios. Therefore, the Guidance encourages entities to share the data generated from testing and deployment of AVs with other entities.

control data should be considered in order both to safeguard the interests of the manufacturers in terms of product liability law and to protect evidence regarding regulatory violations; Goodrich, supra note 72, at 289 (arguing that data recorders would provide valuable data on whether an AV was being operated properly before a specific violation or accident occurred and could help establish civil or criminal liability).


However, detecting the cause of degradations, failures or malfunctions would not be attainable every time due to the lack of transparency of machine-learning algorithms. See Zhongheng Zhang et al., Opening the Black Box of Neural Networks: Methods For Interpreting Neural Network Models in Clinical Applications, 6 ANNALS OF TRANSLATIONAL MED. 216 (2018); Amitai Etzioni & Oren Etzioni, Keeping AI Legal, 19 VAND. J. ENT. & TECH. L. 133, 137 (2016) (“AI-equipped autonomous operating systems are becoming highly opaque–black boxes to human beings: That is, people are unable to follow the steps these machines are taking to reach whatever conclusions they reach.”). See Kai Rannenberg, Opportunities and Risks Associated with Collecting and Making Usable Data, in AUTONOMOUS DRIVING: TECHNICAL, LEGAL AND SOCIAL ASPECTS, supra note 31, at 497, 515 (arguing that although vehicles driving more autonomously do not necessarily cause privacy problems, this would change if the design and architecture of AVs do not effectively address those issues); Walter Wachenfeld & Hermann Winner, Do Autonomous Vehicles Learn?, in AUTONOMOUS DRIVING: TECHNICAL, LEGAL AND SOCIAL ASPECTS, supra note 31, at 451, 468. (arguing that because AVs require data related to occupants, the vehicle and the environment, data protection becomes as relevant as road safety, notwithstanding the issue of data security which should also be addressed); Jack Boeglin, The Costs of Self-Driving Cars: Reconciling Freedom and Privacy with Tort Liability in Autonomous Vehicle Regulation, 17 YALE J. L. & TECH. 171 (2015) (arguing that the California regulation requiring the preservation of detailed records concerning AVs may lead to more continuous and invasive monitoring of AV behavior in the future).

Gasser, supra note 103, at 546.

manufacturers or the public to accelerate knowledge and understanding of AV performance, increase the safety of AV systems, and enhance consumer trust in AV technologies. The Guidance promises that the NHTSA will seek a mechanism to facilitate anonymous data sharing for entities that test and deploy in accordance with antitrust and competition law requirements. The Guidance suggests that such voluntary data exchanges include proactive, data-driven safety, cybersecurity, and privacy protection practices, yet at the same time, respect consumer privacy, as well as proprietary and confidential business information. This effort has recently generated some voluntary data exchanges among the entities developing AV technology.

On December 7, 2017, the U.S. DoT hosted “the Roundtable on Data for Automated Vehicle Safety” to discuss voluntary data exchange use cases that could expedite the safe introduction of AVs into the market. The U.S. DoT developed a draft “Guiding Principles on Voluntary Data Exchanges Accelerate Safe Deployment of Automated Vehicles,” to be used in discussions among participants pertaining to data exchanges for AVs among stakeholders. These principles vary from encouraging proactive, data-driven safety, cybersecurity, and privacy protection practices to the US DoT’s role in stimulating and facilitating voluntary data exchanges.

However, the participants sought clarification on the “voluntary nature” of data exchange activities in these principles along with a clear definition of safety, a categorization of privacy, safety, and cybersecurity, and the identification of data standards and quality—such as timeliness, accuracy, and granularity. As a result, the U.S. DoT created the draft “Framework for Voluntary Data Exchanges to Accelerate Safe Deployment of Automated Vehicles,” in which data

---

410 NHTSA 2018, supra note 23, at 30; NHTSA 2016, supra note 17, at 6–18.
411 NHTSA 2017, supra note 18, at 14; NHTSA 2016, supra note 17, at 35.
414 Roundtable on Data for Automated Vehicle Safety, supra note 282, at 1.
415 Id. at 5.
416 Id. at 19.
417 Id. at 5.
related to cybersecurity incidents, edge cases, near-miss events, performance in safety-critical scenarios could be shared in the industry, such as Automotive Information Sharing And Analysis Center (Auto ISAC). The participants again expressed their concerns about the word “framework” on the basis that it could be interpreted as having implications for data management and ownership. The feedback revealed that this data exchange will be limited to voluntarily exchanges and will not extend to proprietary information or trade secrets.

It is doubtful that AV developers will share all of their data, which includes edge-cases and accident scenarios that are regarded as the most valuable asset for them. MIT researcher Lex Fridman made a convincing argument for this protective behavior:

“[N]obody knows what success in this industry requires. So there’s a feeling of possessiveness about giving away stuff. Doing an occasional demo of autonomous driving through Boston or San Francisco produces a large amount of value. But giving away algorithms or details about the data you collect seems to diminish the value. Right now, it’s a game of hype.”

418 Id. at 20.
419 Id. at 6.
420 Id. at 12 (stating that many participants discussed many overarching challenges that include, among others, the proprietary nature of data gathered by the private sector who sees that data as component of their competitive advantage, and limited incentives for industry or state agencies to exchange data). As a recent example of voluntary data exchange, Waymo published its strategy and systematic approach toward building safe and reliable Level 4 vehicles, including core methodologies and safety governance practices. Francesca Favar6 et al., Building a Credible Case for Safety: Waymo’s Approach for the Determination of Absence of Unreasonable Risk, WAYMO (Mar. 2023), https://storage.googleapis.com/waymo-uploads/files/documents/safety/Waymo%20Safety%20Case%20Approach.pdf.

421 See, e.g., Jeff Plungis, Should Developers of Driverless Cars Share Test Data, CONSUMER REPORTS (Dec. 8, 2016), https://www.consumerreports.org/autonomous-driving/should-developers-of-driverless-cars-share-test-data/ [https://perma.cc/2HHY-VWCU] (reporting that Google, a pioneer company in AV technology, commented that data sharing should not extend to proprietary and sensitive information); David Shepardson, Trump Administration Re-evaluating Self-Driving Car Guidance, REUTERS (Feb. 26, 2017, 4:34 PM), https://www.reuters.com/article/us-usa-trump-selfdriving-idUSKBN1650WA [https://perma.cc/38L4-L7CL] (“Automakers have raised numerous concerns about the guidance, including that it requires them to turn over significant data, could delay testing by months and lead to states making the voluntary guidelines mandatory.”).

Not surprisingly, these entities will promote the safety of their AV technology first, which could be achieved by machine–learning algorithms trained with such complex and complicated data.\textsuperscript{423} It will be more challenging to require these entities to share the most valuable data, which is under either intellectual property or trade secret protection.\textsuperscript{424} This was clearly evident in the legal war between AV developers on trade secrets and patents related to AV technology, specifically lidar sensors.\textsuperscript{425} A former employee of the plaintiff downloaded sensitive and secret information, including 14,000 files, to his personal laptop in late 2015 before he left his job at the plaintiff in early 2016 to launch the defendant start-up, which is acquired by the defendant ride-hailing company in August 2016.\textsuperscript{426} After the plaintiff found that both defendants were using the plaintiff's trade secrets related to lidar designs, it filed the lawsuit against the defendants for 1.6 billion in damages in 2017, alleging trade secret misappropriation, patent infringement, and unfair competition.\textsuperscript{427} The plaintiff and the defendant ride-hailing company settled.\textsuperscript{428} The defendant ride-hailing company agreed to give 0.34 percent of its equity—approximately $245 million—to the plaintiff and not to use the plaintiff's hardware or software intellectual property in its own AV technology.\textsuperscript{429}


\textsuperscript{424} See also Michael Mattioli, Autonomy in the Age of Autonomous Vehicles, 24 B.U. J. SCI. & TECH. L. 277, 297 (2018) (informing that some automakers are not willing to share data in order to prevent competitors reverse–engineer algorithms maintained as trade secrets, and automakers want to protect this data to preserve a competitive advantage); Letter from Anthony Levandowski, Vice–President, Engineering, Uber, to Brian Soublet, Deputy Director and Chief Counsel, Cal. Dep't Motor Vehicles, at 6 (Apr. 24, 2017), https://perma.cc/GTQ9-LETK (“[M]anufacturers must submit a broad amount of testing data and information in order to obtain a deployment permit . . . . this information can be a confidential trade secret, which should not be subject to disclosure.”); Tillemann & McCormick, supra note 423 (“[G]iving up crash data has negative effects for both leaders and laggards. For leaders, it allows competitors to profit from their hard–won knowledge—and, potentially, to catch up. For laggards, it exposes vulnerabilities.”).


\textsuperscript{426} Id. at *1.

\textsuperscript{427} Id. at *1-2.


\textsuperscript{429} Id.
The plaintiff also took action against its former employee. An arbitration panel ruled that the former employee engaged in unfair competition and breached their obligations when he started a rival company and transferred the plaintiff’s some employees. The former employee will have to pay $179 million to the plaintiff. Moreover, the court overseeing the civil case related to trade secret misappropriation referred it to federal prosecutors for a criminal trade-secret case, and the plaintiff co-operated with federal prosecutors to start this investigation. As a result, the former employee pleaded guilty to stealing the plaintiff’s confidential information and admitted that the documents he downloaded were a trade secret and he intended to use them for himself and the defendant ride-hailing company. This incident triggered paranoia among the plaintiff’s former employees, who now work for different AV developers. More importantly, this incident showed how AV developers are protective of their technology.

Moreover, the construction and maintenance costs of a database collecting all AV developers’ data may be expensive and require the NHTSA to protect this sensitive information. Were such sensitive data to be hacked, AV developers would lose their competitive advantage, which has been years in the making. Further, privacy concerns might.

---


431 Id.

432 Id.


435 See Duhigg, supra note 433 ("Some people who have left Waymo told me that they have received frightening letters from their former employer warning them about the dangers of using misappropriated technology—and asserting that Waymo will sue them, if necessary. A former Waymo employee who is now working for another company said that the scare tactics had been effective: 'We made a deliberate decision not to do anything that might compete in any way with Waymo. It's terrifying to think they might come after you.'").
arise, as two important factors—safety and privacy—may come into conflict.\textsuperscript{436}

Therefore, there are significant technical and legal barriers in front of establishing a framework to share valuable data in the industry. In fact, the NHTSA's fourth policy issued recently \textit{may} indicate the Agency may no longer be supportive of data sharing. The policy emphasized that the U.S. government will protect and enforce intellectual property rights, sensitive data, and sensitive proprietary communications\textsuperscript{437} and does not mention anything about data sharing: \textsuperscript{438}

"AV technology will rely heavily on intellectual property in the form of patents, trade secrets, copyrighted software, and trademarked goods. For the United States to successfully adopt this technology, the intellectual property of American innovators—and the safety of the American public—will both need to be protected . . . . Innovators and entrepreneurs in the AV field should be aware of USPTO, as securing a patent, trademark, or both serves not only to afford them important legal rights, but also to help preserve the United States' technological edge, which is key to our current and future competitiveness in AV technologies."

X. DISCLOSURE, WARNING, AND MISREPRESENTATION REQUIREMENTS

A. Disclosure

The Guidance encourages entities to disclose—especially to states and consumers—how they deal with the safety elements suggested in the policy. This includes matters like communication and collaboration with the U.S. DoT; the development of industry safety norms, public trust, acceptance, and confidence via transparent testing and deployment of AVs.\textsuperscript{439} These disclosures are called Voluntary Safety Self-Assessment.\textsuperscript{440} The Guidance, however, cautions that entities do not need to reveal proprietary intellectual property and confidential business information and clarifies that this disclosure recommendation

\textsuperscript{436} See Mattioli, \textit{supra} note 424, at 295.
\textsuperscript{437} NHTSA 2020, \textit{supra} note 17, at 33.
\textsuperscript{438} Id. at 33-34.
is voluntary to avoid delays in testing and deployment. The main objective of the disclosure requirements is to facilitate the identification of causes of problem and thus support identification of improvements that might lessen the likelihood of future problems. However, AV developers have generally overlooked these voluntary self-assessments because of the voluntary nature of the Guidance. Regarding state regulations, California requires manufacturers to record data on disengagement of the autonomous mode that result from either a system failure or a request for the driver to take immediate control of the AV to handle a dangerous situation. Disengagement reports are expected to clarify the circumstances that trigger disengagements, including the location, weather conditions, traffic conditions, collisions, emergencies, and accidents. Several other states mandate similar disclosure. These reports can provide transparency and accountability for the public, which needs to know the level of maturity of the technology in terms of safety and quality.

441 NHTSA 2017, supra note 18, at 16.
442 NHTSA 2016, supra note 17, at 80.
444 CAL. CODE REGS. tit. 13, § 227.50(a) (2022).
445 Id. § 227.50(b)(3) (2022).
446 Likewise, the state of Massachusetts follows the state of California and requires that the applicant submit a Progress Report at least quarterly, which also must be shared publicly. THE MASSACHUSETTS MEMORANDUM, supra note 42, 8(a). This report includes, among others, a description of takeover procedures and all ADS failures and citations or violations during testing, including time, location, type of roadway, weather conditions, vehicle speed, and the factual circumstances of any accidents that occur. Id. 8(a)(i)(2)(6). See Ohio Exec. Order No. 2018-01K (2018), 6(g) (requiring that a designated operator report any collision resulting from the operation of the autonomous vehicle during the active engagement of the autonomous technology on a public road).
447 See, e.g., Winkle, supra note 176, at 613 (arguing that transparency promotes and accelerates public discourse across all disciplines). This is because of the lesser number of accidents involving AVs and fewer disengagements that AVs experience may prove that AV technology has reached a point where the public can trust AVs and use them confidently. See, e.g., Andrew J. Hawkins, California is Warming Up to Self-Driving Cars Without a Human Driver, THE VERGE (Mar. 10, 2017, 3:17 PM EST), https://www.theverge.com/2017/3/10/14881640/california-dmv-self-driving-car-rules-human-driver [https://perma.cc/HK53-YPJR] ("This disengagement rate is then disclosed
Moreover, AV developers learn from the data about mistakes and challenges that others have experienced during testing and operation, with the aim of avoiding their repetition.

On the other hand, these entities are unlikely to welcome sharing data, data being one of developers’ most valuable assets, gathered as a result of a great effort. It is not surprising that entities developing AV technology and testing it in California expressed their concern about data-sharing requirements, claiming that the data available to the public upon request can be unfairly obtained and used by competitors, who may gain an edge from it. Moreover, many AV developers and experts criticized sharing disengagement reports used for comparing one AV developer with another simply because these reports do not indicate whether AV technology is ready for commercial deployment.

Disclosure requirements that can reveal AV developers’ data, which have been gathered expensive and complicated testing efforts, should not be imposed on AV developers. AV developers clearly do not want to lose their competitive advantage. Data sharing should be voluntary, i.e., without any mandatory requirement, and the industry should decide itself on the scope of data sharing. If, in fact, new FMVSS had been implemented by the NHTSA or specific legislation had been enacted by Congress, there would have been no need for such state regulation regarding data disclosure.

publicly by the DMV. Some companies, like Google, use the disengagement rate to highlight its improving technology.


On the other hand, disclosure requirements would be useful to monitor crashes involving AVs, which would show the state of AV technology to the public and enable regulators to identify safety defects before more serious harms occur. Because of these reasons, the NHTSA issued Standing General Order 2021-01 on June 29, 2021 which requires vehicle and equipment manufacturers to report crashes involving AVs and Level 2 ADAS to the Agency.\footnote{U.S. DEP’T OF TRANS. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., INCIDENT REPORTING FOR AUTOMATED DRIVING SYSTEMS (ADS) AND LEVEL 2 ADVANCED DRIVER ASSISTANCE SYSTEMS (ADAS), at 2, https://www.nhtsa.gov/sites/nhtsa.gov/files/2021-06/Standing_General_Order_2021_01-digital-06292021.pdf. As of May 15, 2022, 25 reporting entities have submitted crash reports for 130 crashes involving AVs to the NHTSA. U.S. DEP’T OF TRANS. NAT’L HIGHWAY TRAFFIC SAFETY ADMIN., DOT HS 813 324, SUMMARY REPORT: STANDING GENERAL ORDER ON CRASH REPORTING FOR AUTOMATED DRIVING SYSTEMS (2022), https://www.nhtsa.gov/sites/nhtsa.gov/files/2022-06/ADS-SGO-Report-June-2022.pdf.} Apart from reporting crashes to the Agency, however, disclosure requirements should not be extended to AV developers’ proprietary data.

B. Warning Requirements

The recent experience of Level 2 vehicles revealed that salespeople may not possess the requisite detailed knowledge about the operation and limitation of these vehicles.\footnote{Pearl, supra note 352, at 734.} This will likely repeat for Level 3 and 4 vehicles, which makes the proper education of salespeople essential for adequately informing consumers. Moreover, as stated above, drivers are likely to overestimate the capabilities of AVs, especially Level 2 and 3 vehicles. Consumer education on the capabilities and limitations of AVs is also necessary to ensure the safe operation of AVs.

The Guidance rightly recommends AV developers develop employee, dealer, distributor, and consumer education and training programs that explain the differences in the operation of AVs from conventional vehicles,\footnote{NHTSA 2018, supra note 23, at 26; NHTSA 2017, supra note 18, at 15; NHTSA 2016, supra note 17, at 24.} and the necessary level of understanding for the target users to operate these vehicles properly, efficiently, and safely.\footnote{NHTSA 2018, supra note 23, at 29; NHTSA 2017, supra note 18, at 15; NHTSA 2016, supra note 17, at 24. More importantly, the proposed consumer education should cover many topics, including the AV system’s intent, operational parameters, capabilities and limitations, engagement/disengagement methods, the human–machine interface, emergency fall back scenarios, operational boundary responsibilities, and mechanisms that affect function behavior in service. NHTSA 2017, supra note 18, at 15; NHTSA 2016, supra note 17, at 24.} The Guidance also recommends that manufacturers, dealers,
and distributors may consider on–road or on–track hands–on experience that demonstrates AV operations and the human–machine interface functions before release to the consumer. For example, a survey revealed that drivers who received an in–person, on–road demonstration from an expert for how to use a Level 2 driving automation system are significantly more likely to show on–road behaviors that indicate higher levels of confidence in comparison with those who received video training. In addition to its significance in warning consumers about potential risks, consumer education and training will ensure a safe transition period for the public introduced to new technology.

Although concise and plain language to describe the ODD in the owner’s manual should include the vehicle’s other capabilities and limitations, the current manuals may fail to convey adequately similar important information in Level 2 vehicles. This is again related to voluntary nature of the Guidance, which fails to require manufacturers to follow these suggestions. That said, a failure of the tort duty to warn could arise in the future if AV developers do not adequately inform consumers about the capabilities and limitations of their vehicles. Or, misrepresentation cases would arise if salespeople represent lower level vehicles as higher level vehicles in terms of capabilities and limitations, even though these oral statements will likely not survive language in the contract of sale.

In terms of state regulations, California is a pioneer in compelling manufacturers to develop a consumer education plan that addresses the ODD available. California also mandates disclosure of restrictions of the AV system and an explanation of the educational materials for end–users. Awareness of the capabilities and limitations


\[457\] See Pearl, supra note 352, at 735 (“A quick scan of some of these car manuals suggest that even careful readers may have to parse the language therein carefully to understand how the autonomous features on their vehicles work.”).

\[458\] CAL. CODE REGS. tit. 13, § 228.06(c)(1) (2022).

\[459\] Id. § 228.06(c)(A) (2022). Moreover, a vehicle operator instruction guide or pamphlet must be produced that (i) details a readily accessible mechanism; (ii) offers a visual indicator showing the engagement of the AV system inside the AV cabin; and (iii) outlines the responsibilities of the operator and the manufacturer regarding the operation of AVs. Id. § 228.06(c)(1)(B)(i)–(iii) (2022). California also requires a manufacturer to explain how end–users will be educated after buying a second–hand AV. Id. § 228.06(c)(1)(C) (2022).
of these vehicles is vital for the human driver to participate effectively in the human–machine interface. After reviewing their regulations, if necessary, other states should implement the requirement of a consumer or end–user education plan as California has done. States should also mandate that purchasers receive in-person on-road demonstration and watch video tutorials designed by manufacturers on the limitations of AVs and the differences between each level before car dealerships hand over the keys.  

C. Misrepresentation Requirements

The capabilities and limitations of AVs might be misrepresented in order to increase the sales of such vehicles, especially for Level 2 and 3 vehicles. “Autonowashing,” a term coined by Liza Dixon, corresponds to the practice of exaggerating the capabilities of AVs. In fact, the recent experience of Level 2 vehicles has taught us that the names used for these vehicles might be deceptive. For example, the name “Autopilot” for a Level 2 vehicle raised the question of whether this usage encouraged the assumption that the vehicle could drive under all conditions. The vehicle is promoted as being capable of relieving drivers of the most tedious and potentially hazardous aspects of road travel, yet at the same time requiring the driver’s ultimate availability and responsibility for the car. Experts warn that these two contrasting messages not only increase driver confusion but may also make drivers unaware of the need to react quickly to emergencies. Also, European

460 Pearl, supra note 352, at 748.
461 See, e.g., LIZA DIXON, AUTONOWASHING: THE GREENWASHING OF VEHICLE AUTOMATION, 5 TRANS. RES. INTERDISC. PERS. 4 (2020) (“Over the past decade, terms such as “autonomous”, “driverless”, and “self-driving” . . . are often used by media outlets and OEMs to describe all levels of vehicle automation, baiting interest, sales and “driving traffic” to their respective sites) (emphasis added).
462 Id. at 3.
465 Id.
466 Id. (“By marketing their feature as “Autopilot,” Tesla gives consumers a false sense of security,” says Laura MacCleery, the vice president of consumer policy and mobilization for Consumer Reports . . . . ‘Autopilot’ can’t actually drive the car, yet it allows consumers to have their hands off the steering wheel for minutes at a time. Tesla should disable
New Car Assessment Programme (EURO NCAP) released the assessment of ADAS in 2020 model vehicles commented about "Autopilot" and found the term "inappropriate" because it suggests "full automation." 467

Californian legislators wisely foresaw this danger and prohibited the use of the term "autonomous" in advertisements for AVs unless the vehicle in question satisfies the standards of Level 3, 4 or 5 vehicles 468 and is produced by a manufacturer that holds a valid AV manufacturer's permit at the time of the production. 469 The regulation aims to prevent the use of terms in advertising that induce consumers to believe that a vehicle is autonomous, even though a reasonable consumer would appreciate that the vehicle is not capable of such performance. 470 This regulation was interpreted to ban the use of terms "Autopilot," "Self-Driving," or "Automated" lest they mislead consumers that the vehicle is autonomous. 471 However, this authority has not been used by the CDMV to ban the usage of "Autopilot." 472

On the other hand, Tesla offers a "Full Self Driving" Computer that provides more active guidance and automatic driving for its Level 2 vehicles. 473 The term "Full Self Driving" implies that the vehicle can execute all aspects of the driving task, irrespective of human intervention, which only Level 4 and 5 vehicles can achieve. However, Tesla also put the statement that "no Tesla cars are fully autonomous automatic steering in its cars until it updates the program to verify that the driver's hands are on the wheel."). For example, while the driver of the Level 2 vehicle was checking on his dog in the back seat, the vehicle hit the rear of a cruiser and then a disabled motorist. Bill Flood, State Police: Cruiser Struck by Tesla 3 in “Autopilot” Mode, FOX61 (Dec. 7, 2019), https://www.fox61.com/article/news/state-police-cruiser-struck-by-tesla-3-in-autopilot-mode/520-925755cc-aa28-426f-bbfc-d22160246cb5 [https://perma.cc/D29V-PFB5].

469 Id. § 228.28(a)(2) (2022).
470 Id. § 228.28(b) (2022).
472 For example, Tesla is still using the term “Autopilot” to advertise its Level 2 vehicles. Future of Driving, TESLA, https://www.tesla.com/autopilot [https://perma.cc/MSH3-LPCU].
today and require active driver supervision." These two incompatible meanings may cause confusion among consumers and may lead consumers to behave irresponsibly. The CDMV has recently, and rightly, started an investigation on whether the term “Full Self Driving” violates the rule that aims to prevent using terms that may induce a reasonable person to think that a vehicle is autonomous. This is absolutely a rightful concern, as the recent data shows that Level 2 vehicles involved in 392 crashes between June 29, 2021 and May 15, 2022, and 273 of vehicles involved in these accidents were Tesla’s.

In fact, a Munich Court in Germany banned using the terms “Autopilot included” and “Full Self Driving” in ad statements for Tesla’s Level 2 vehicles, ruling that they are misleading about the capabilities of these vehicles. The court ruled that these terms constitute misleading business practices that may lead average consumers to think that the vehicle could drive fully autonomously without human intervention.

---

474 Id. See also Jon Fingas, Tesla Will Dramatically Expand Its Full Self-Driving Beta, ENGADGET (Mar. 6, 2021), https://www.engadget.com/tesla-full-self-driving-beta-expansion-8-3-171559184.html
475 CAL. CODE REGS. tit. 13, § 228.28(b).
476 Id.
479 Alexandar Huebner, German Court Bans Tesla Ad Statements Related to Autonomous Driving, REUTERS (July 14, 2020, 9:54 AM), https://www.reuters.com/article/us-tesla-autopilot-germany-idUSKCN24F1T5
480 Id.
Although misrepresentation cases will be dealt with primarily by state law, the U.S. Government may also enforce existing laws in order to prevent deceptive claims or those that mislead the public about AV technologies. Also, the Congress and the NHTSA should also follow California's and the Munich Court's path and implement regulation that prohibits specifically terms exaggerating capabilities of AVs ex ante.

XI. PLATOON TECHNOLOGY

Connected vehicle technology allows data transfer between various nodes, including vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian, vehicle-to-network, vehicle-to-device. The combination of all of these is called vehicle-to-everything (V2X) transfer. Dedicated short-range communications (DSRC), a wireless technology, is specifically designed for vehicles which are part of connected vehicle technology and uses radio frequencies. Connected vehicle technology allows data transfer between various nodes, including vehicle-to-vehicle (V2V), vehicle-to-infrastructure (V2I), vehicle-to-pedestrian, vehicle-to-network, vehicle-to-device. The combination of all of these is called vehicle-to-everything (V2X) transfer. Dedicated short-range communications (DSRC), a wireless technology, is specifically designed for vehicles which are part of connected vehicle technology and uses radio frequencies.

481 See, e.g., Complaint, Matsko v. Tesla Inc., Case 3:22-cv-05240, Sept. 14, 2022 (N.D. Cal.) (in a class action suit against a manufacturer selling Level 2 vehicles, the plaintiff relied on, inter alia, negligent misrepresentation theory on the grounds that the manufacturer misrepresented the capabilities and limitations of Level 2 vehicles as capable of full self-driving).

482 NHTSA, supra note 17, at 35. For example, the Federal Trade Commission (FTC) may use its authority to take action against an entity engaging with deceptive claims related to the capabilities and/or limitations of AVs. See 15 USCS § 45. In his comment on the term “Full Self Driving,” Prof. Bryant Walker Smith, a leading expert on AVs and law stated that Tesla’s disclaimer that its vehicles are not autonomous and require active driver supervision would be a weak defense against possible deceptive marketing allegations under the Lanham Act by the FTC. Russ Mitchell, DMV Probing Whether Tesla Violates State Regulations With Self-Driving Claims, L.A. TIMES (May 17, 2021, 12:28 PM), https://www.latimes.com/business/story/2021-05-17/dmv-tesla-california-fsd-autopilot-safety [https://perma.cc/6Z7Y-P73R].


484 DSRC uses radio frequencies of 75 MHz of licensed spectrum in the 5.9 GHz band allocated by the Federal Communications Commission (FCC). IEEE 802.11p, a standard for DSRC on wireless access in vehicular environments, has been approved and enacted by many carmakers and the U.S. Department of Transportation. David Elliot et al., Recent Advances in Connected and Automated Vehicles, 6 J. TRAFFIC & TRANSP. ENG’G 110, 111 (2019). The U.S. DoT promises to preserve the ability for transportation safety applications to operate in the 5.9 GHz spectrum, yet is also searching methods for sharing the spectrum with other users without hindering its priority use for vehicle safety communications. NHTSA, supra note 23, at 16–17.
Vehicle technology allows vehicles to share relevant traffic and crucial information among each other and with infrastructure via wireless network and sensors while driving.\textsuperscript{485} For example, an algorithm can use the information obtained from connected vehicles in order to determine the sequence of departures from a given intersection, thereby minimizing total delay and the total number of stops.\textsuperscript{486} Connected vehicle technology has therefore been compared with the adoption of seatbelts, airbags, and the U.S. interstate highway systems given its potential to significantly contribute to the road safety.\textsuperscript{487}

Yet, V2X technology is not perfect and has drawbacks. An urban environment may adversely affect V2V and V2I communication due to multiple propagation paths and various obstructions, especially areas in which information sent by V2V would be most effective in case of obstacles, blind spots, buildings and so on.\textsuperscript{488} V2X communication may not result in reliable and on-time information when there are many cars around.\textsuperscript{489} Poor weather conditions can also affect the performance of DSRC.\textsuperscript{490}

The primary justification behind the design of DSRC was to enable a quick transfer of short-range essential safety messages. However, DSRC is currently not able to provide high bandwidth and


\textsuperscript{486} Connected Vehicle technology has therefore been compared with the adoption of seatbelts, airbags, and the U.S. interstate highway systems given its potential to significantly contribute to the road safety.

\textsuperscript{487} Damon Lavrinc, \textit{Feds Will Require All New Vehicles to Talk to Each Other}, WIRED (March 2, 2014), https://www.wired.com/2014/02/feds-v2v/ [https://perma.cc/A5JC-2ZQB].

\textsuperscript{488} Scott Biddlestone et al., \textit{An Integrated 802.11p WAVE DSRC and Vehicle Traffic Simulator With Experimentally Validated Urban (LOS and NLOS) Propagation Models}, 13 IEEE TRANSACTIONS ON INTELLIGENT TRANSP. SYS. 1792 (2012); Andreas Geiger et al., \textit{Team AnnieWAY's entry to the Grand Cooperative Driving Challenge 2011}, 13 IEEE TRANSACTIONS ON INTELLIGENT TRANSP. SYS. 1008, 1014 (2012).

\textsuperscript{489} Claudia Campolo et al., \textit{Modeling Broadcasting in IEEE 802.11p/WAVE Vehicular Networks}, 15 IEEE COMM. LETTERS 199, 201 (2011) ("The low values of packet delivery ratio, especially for high $N$ and low $W$ values, are due to the increase in collisions among nodes attempting to seize the channel at the beginning of the CCH interval.")

\textsuperscript{490} Seungbae Lee & Alvin Lim, \textit{An Empirical Study on Ad Hoc Performance of DSRC and Wi-Fi Vehicular Communications}, 9 INT’L J. DISTRIBUTED SENSOR NETWORKS 1, 2 (2013).
low latency communication channels for V2X communication.\textsuperscript{491} A V2V failure may lead to more hazardous events compared to a single sensor failure.\textsuperscript{492} From an economic and practical perspective, constructing, maintaining and guaranteeing a reliable public infrastructure for AVs will require significant investment.\textsuperscript{493} Therefore, V2X should not be seen as a precondition to the deployment of AVs, as the U.S. DOT rightfully points out.\textsuperscript{494}

Some states took early action and regulated some but not all aspects of V2X technology. Specifically, some permit the deployment of a platoon technology, which enables a group of individual commercial motor vehicles to travel at close following distances in a unified manner via an electronically interconnected braking system.\textsuperscript{495} Although this definition has similar characteristics to V2V technology,

\footnotesize
\textsuperscript{491} Elliot, supra note 484, at 113. A promising alternative to DSRC would be cellular-based V2X communications, i.e. 5G C-V2X that aims to provide higher throughput and reliability, extended range, lower latency, ubiquitous connectivity, and precise position determination use cases, some of which will simultaneously work together along with cameras, radar and lidar. IEEE, IEEE 5G AND BEYOND TECHNOLOGY ROADMAP WHITE PAPER (2017), https://futurenetworks.ieee.org/images/files/pdf/ieee-5g-roadmap-white-paper.pdf. 5G C-V2X has the potential to become a new type of sensor. 5G AMERICAS, CELLULAR V2X COMMUNICATIONS TOWARDS 5G, at 18 (2018), http://www.5gamericas.org/files/9615/2096/4441/2018_5G_Americas_White_Paper_Cellular_V2X_Communications_Towards_5G_Final_for_Distribution.pdf. The Federal Communications Commission (FCC) took an action and declared the Facilitate America’s Superiority in 5G Technology Plan (the 5G FAST Plan) in June 2018, which incorporates three important components: (i) pushing more spectrum into marketplace; (ii) updating infrastructure policy; and (iii) modernizing outdated regulations. Fed. Comm. Comm’n, The FCC’s 5G Fast Plan, https://www.fcc.gov/5G [https://perma.cc/S5CT-XSRA] (last visited on Mar. 1, 2020).

\textsuperscript{492} Ellen van Nunen et al., Sensor Safety for the European Truck Platooning Challenge, 23RD ITS WORLD CONGRESS 1 (2016).

\textsuperscript{493} JAMES M. ANDERSON ET AL., AUTONOMOUS VEHICLE TECHNOLOGY: A GUIDE FOR POLICYMAKERS 67 (2016).


\textsuperscript{495} N.C. GEN. STAT. § 20-152(c); KY. REV. STAT. ANN. § 281.764(1); KY. REV. STAT. ANN. § 281.010(39); NEV. REV. STAT. ANN. § 482A.032; N.D. CENT. CODE § 39-10-18(5); TENN. CODE ANN. § 55-8-201(a); TENN. CODE ANN. § 55-8-101(52); UTAH CODE ANN. § 41-6a-711(1); LA. STAT. ANN. § 32:31(D); LA. STAT. ANN. § 32:1(48.1); MISS. CODE. ANN. § 63-3-619(3)(b); MISS. CODE ANN. § 63-3-103(k); OKLA. STAT. tit. 47, § 11-310(f); WIS. STAT. ANN. § 346.14(1b); 75 PA. STAT. AND CONS. STAT. ANN. § 102; MICH. COMP. LAWS ANN. § 257.665(9)(10); MINN. STAT. ANN. § 169.881(1)(a); MINN. STAT. ANN. § 169.011(54b); OR. REV. STAT. ANN. § 811.485(3)(b); OKLA. STAT. tit. 47, § 11-310(f); TENN. CODE ANN. § 55-8-201(c)(2).
it is actually narrower on the basis that V2V communication provides the data transfer on not only speed but also intersections, traffic lights, accidents, and the like. As a more inclusive definition, the state of Illinois defines “connected vehicle” as a vehicle that deploys wireless communication to communicate and exchange information with other vehicles, infrastructure, other devices outside the vehicle, and external networks.496

Since traffic law generally prohibits following another vehicle too closely,497 many states excuse the driver of a commercial motor vehicle traveling in a platoon from the rule that prohibits following another vehicle more closely than that is reasonable and prudent.498 Another common requirement is that an appropriately certified driver who has a valid commercial driver's license may be required to be present behind the wheel of each vehicle in a platoon.499 These provisions modify existing rules designed for human drivers and provide consistency, thereby paving the way for V2V technologies.

Overall, it appears that platoon technology is legislated as an ADAS rather than a feature that AVs possess and is still in its infancy as far as application to AVs is concerned.500 Some states have modified their former regulations prohibiting close following of vehicles on the road (i.e., more than is reasonable and prudent). Also, states’ regulations still assume that a human driver will be present behind the wheel and be responsible if he or she does not take control when the system fails. However, the regulation of platoon technology is narrower than that of V2V technology, and supports the conclusion that V2X and AV technologies are evolving separately. Either way, such legislation creates the environment for platoon technology to develop and be used in AVs in the future.

496 THE ILLINOIS EXECUTIVE ORDER, supra note 28, (II)(1)(c) at 2.
497 See, e.g., CAL. VEH. CODE § 21705 (prohibiting driving motor vehicles less than 100 feet between each vehicle or combination of vehicles so as to enable any other vehicle to overtake or pass)
498 N.C. GEN. STAT. § 20-152(c); N.D. CENT. CODE § 39-10-18(4); OR. REV. STAT. ANN. § 811.485(3)(a); 75 PA. STAT. AND CONS. STAT. ANN. § 3317(b); TENN. CODE ANN. § 55-8-124(d); UTAH CODE ANN. § 41-6a-711(3); LA. REV. STAT. ANN. § 32:81(E); WIS. STAT. ANN. § 346.14(2)(c); S.C. CODE ANN. § 56-5-1930(D); MISS. CODE ANN. § 63-3-619(3)(a).
499 KY. REV. STAT. ANN. § 281.764(4); TENN. CODE ANN. § 55-8-201(c)(3); MICH. COMP. LAWS ANN. § 257.665(9)(10); 75 PA. STAT. AND CONS. STAT. ANN. § 3317(d); MINN. STAT. ANN. § 169.881(4).
500 See also Glancy, supra note 56, at 627. (arguing that vehicles in platoons would not be classified as AVs because they still need human drivers even though there is no need for their active duty during much of the journey, which should be distinguished from fully AVs that operate by itself at all times).
XII. THE SUPREMACY OF FEDERAL LEGISLATION AND REGULATION

New federal standards or legislation will and should be enacted to address AVs. When that happens, federal law has supremacy over state law and may preempt any relevant state law if it is found that state law is preempted. The federal preemption doctrine is rooted in the Supremacy Clause of the U.S. Constitution. Preemption may result from a federal agency working within the scope of its authority allocated by the Congress, and as a result, new FMVSS for AVs promulgated by the NHTSA may preempt state regulation. Preemption is justifiable in the context of products liability law on the basis that manufacturers could not comply with a patchwork of federal and state laws, and expects that federal safety–related statutes, or administrative regulations according to these statutes, supersede overlapping state regulations that are not consistent with the federal standard.

Preemption can be either ‘express or implied, and is compelled whether Congress’ command is explicitly stated in the statute’s language or implicitly contained in its structure or purpose. An express preemption can be found in explicit statutory or regulatory language, and is correctly found ‘[w]hen Congress has considered the issue of preemption and has included in the enacted legislation a provision explicitly addressing that issue’, and when that provision provides a ‘reliable indicium of congressional intent with respect to state authority.’ Typical express preemption provisions prohibit States from enacting discordant or disparate “requirements,” “statements,” or “standards” in comparison with those required by the federal law.

501 U.S. CONST. art. VI, cl. 2. (“This Constitution, and the Laws of the United States . . . shall be the supreme Law of the Land; and the Judges in every State shall be bound thereby, any Thing in the Constitution or Laws of any State to the Contrary notwithstanding.”).
504 OWEN & DAVIS, supra note 503, § 15:1 (quoting Jones v. Rath Packing Co., 430 U.S. 519, 525 (1977)).
505 Id. (quoting Jones v. Rath Packing Co., 430 U.S. 519 (1977)).
506 Id. § 15:4.
If the congressional intent to preempt state law is not expressly stated in a federal legislation, it should be determined whether such intent "impliedly" exists.\textsuperscript{507} Therefore, implied preemption must be inferred from both an assessment of the language of the statute and an evaluation of the general statutory and regulatory objectives.\textsuperscript{508}

In the federal motor vehicle context, an express preemption provision exists and states that if an FMVSS exists, and a state or a political subdivision of a state is barred from enacting a standard that is not identical to a federal one.\textsuperscript{509} Besides, states are allowed to require a standard for a motor vehicle or motor vehicle equipment obtained for its own use that sets out a higher performance requirement than the otherwise applicable standard imposed by the NHTSA.\textsuperscript{510} Alternatively, states may choose to impose a standard that is identical to a standard prescribed by the NHTSA.\textsuperscript{511}

Current state regulation on AVs not only present several distinct approaches toward AVs but also has the potential to create a conflict between state and federal law. The U.S. DoT admits that the NHTSA's application of FMVSS to assess the performance of AVs is likely to raise questions regarding preemption and the future interaction among federal, state and local powers.\textsuperscript{512} Even now, some states that have enacted legislation or adopted regulations about AVs explicitly accept the supremacy of any federal regulation arising in the future.\textsuperscript{513} The NHTSA’s latest regulation has not promulgated any specific standards related to AVs at the time of writing, it changes certain occupant protection FMVSSs to pave the way for AVs that do not have the traditional manual controls designed for human drivers. Thus, states should modify their regulations to comply with the changes in occupant protection FMVSS. In other aspects of AV technology states regulated, federal law will and should come to preempt state legislation via some

\textsuperscript{507} See, e.g., Buckman Co. v. Plaintiffs' Legal Committee, 531 U.S. 341, 352 (2001); U.S. v. Locke, 529 U.S. 89, 90 (2000) ("[A]n 'assumption' that the States' historic police powers were not to be superseded by federal law unless that was the clear and manifest congressional purpose does not mean that a presumption against pre-emption . . . ").

\textsuperscript{508} OWEN & DAVIS, supra note 503, § 15:1.

\textsuperscript{509} 49 USCS § 30103(b)(1).

\textsuperscript{510} Id.

\textsuperscript{511} Id. §30103(b)(2).

\textsuperscript{512} NHTSA, supra note 23, at 6.

\textsuperscript{513} See, e.g., CAL. VEH. CODE § 38750(g); FLA. STAT. ANN. § 319.145(4) (accepting the supremacy of federal regulation in case of conflict with a future federal regulation which would be enacted by the NHTSA); NEV. REV. STAT. ANN. § 482A.080(3) (stating that an AV may be tested or operated with a human operator provided that, among others, the behavior of AV complies with the federal regulation if a federal regulation exists for AVs).
kind of regulatory or statutory enactment to resolve current inconsistency between state legislation.\textsuperscript{514}

XIII. CONCLUDING REMARKS

This Article engaged in an in–depth critical analysis of “the Guidance”—four policies on AVs issued by the U.S. DoT. The Guidance aims to provide flexibility, responsiveness, and an environment for cost–effective innovation—it is, thus, an efficient non–regulatory way to assist the safe introduction of AVs. However, the Guidance is vague even though there are already available solutions that could be imposed on AV developers. The Guidance, as soft law, errs on the side of generalities to be flexible, and its voluntary nature has the potential to hamper the pursuit of harmonization among stakeholders—who remain free to think first in terms of self–interest. Thus, the Guidance is not adequate to protect the needs and rights of weak stakeholders, such as end users.\textsuperscript{515} Since soft law is never an optimal choice to achieve neutral, independent, and inclusive regulation in the long run,\textsuperscript{516} we need mandatory regulation—in terms of the measures, designs, and practices mentioned above—that is legally binding on all AV developers. That the NHTSA has delayed action is problematic but also to be expected, given the track record of government agencies and technological change historically.\textsuperscript{517}

The NHTSA’s latest regulation is certainly a crucial step to remove regulatory barriers for AVs that do not have the traditional manual controls. Yet, this regulation is too narrow to address the safety of AVs. First, it focuses on the crashworthiness (200-series) FMVSSs, which means that regulatory barriers still remain in the language of other FMVSSs and that AV developers will have to seek an exemption

\textsuperscript{514} See also Glancy, supra note 56, at 655; Goodrich, supra note 72, at 291. (urging Congress and the U.S. DoT to enact uniform regulations for AVs).


\textsuperscript{516} Id. at 35.

from these FMVSSs in order to manufacture their AVs for sale. Second, this regulation applies to AVs that have conventional seating position, i.e., forward-facing front seating positions, and excludes AVs that have rear-facing seating or campfire seating positions. Third, this regulation does not extend to the most significant aspects of AV technology—such as safety, cybersecurity, performance, validation methods, and teleoperation—and thus, these aspects remain unregulated.

A more cynical position might contend the Agency has simply chosen to use stealth regulations to escape from the accountability and transparency requirements that current administrative law mandates. Such position is true and wrong at the same time. It is true because the NHTSA is overly concerned that premature enactment of a FMVSS without the appropriate knowledge might cause an unreliable sense of security, which in turn culminates in negative safety results and hampers the development of AV technology. It is wrong because the Agency has been continuing its regulatory efforts and research to adopt

---

518 For example, the crash avoidance (100-series) FMVSSs inherently assume that a human is executing the driving task with manually operated driving controls. MICHELLE CHAKA ET AL., FMVSS CONSIDERATIONS FOR VEHICLES WITH AUTOMATED DRIVING SYSTEMS: VOLUME 2, U.S. DEP'T OF TRANSP. NAT'L HIGHWAY TRAFFIC SAFETY ADMIN., DOT HS 813 024, at viii (2021), https://rosap.ntl.bts.gov/view/dot/54442. The NHTSA is aware of this fact and explicitly mentioned in its final rule that “other regulatory changes to the FMVSS not impacted by this rulemaking (e.g., with regard to the 100-Series FMVSSs) would likely be necessary to permit such a vehicle to be manufactured for sale, even with the changes made by this rule (absent an exemption to the FMVSS under 49 CFR part 555).” NHTSA, supra note 10, at 18567 fn. 29.

519 See id. at 18562. For example, General Motors (GM) has recently sought a temporary exemption from certain requirements in six FMVSSs, including FMVSS No. 208 for its AV, called the “Cruise Origin.” General Motors—Receipt of Petition for Temporary Exemption From Various Requirements of the Federal Motor Vehicle Safety Standards for an Automated Driving System- Equipped Vehicle The Origin, 87 Fed. Reg. 43595 (July 21, 2022). The Cruse Origin has rear-facing seating positions, which includes a front row of seats that faces backwards and a back row of seats that faces forwards. Id. at 43597. Thus, the NHTSA’s final regulation does not help AV developers that adopt new designs for AVs, and force them to apply for an exemption procedure, which takes time and money.

520 For example, the Insurance Institute for Highway Safety (IIHS) raised its concern that the NPRM enables the deployment of AVs in the absence of regulations that ensure the safe behavior of AVs. NHTSA, supra note 10, at 18564.


new FMVSSs that ensure the safe operation of AVs. This is understandable given the pace of innovation taking place in the AV industry. Yet, if this inaction continues much longer, the NHTSA and Congress will likely endanger public safety, thus violating its own prime directive.

In the absence of preemptive federal regulation that regulates all aspects of AV technology, states have enacted legislation, executive orders, or guidelines to foster innovation in AVs. This effort has generated pioneering rules that may be borrowed by federal legislators and regulators in the future, yet no state has enacted a legislative model that addresses all legal issues potentially arising from the operation of AVs.

Among all states that regulated AVs, California is distinguished due to its pioneering role. First, California’s regulation requires manufacturers to demonstrate they have conducted relevant tests and validations for the safety of AVs and complied with “appropriate and applicable” industry cybersecurity standards. Second, California is also a pioneer by requiring reporting of safety-related defects, descriptions of how an AV satisfies Level 4 and 5 vehicle standards, and submitting a summary of testing results in ODD. Third, Californian regulators made an optimal regulatory decision by requiring updates for changes in the behavior of the AV system and location and mapping information.

However, these regulatory requirements for AV technology in California remain too broad to ensure the safety of AVs. In any case, these requirements direct performance of AVs, and thus, have a potential to trespass the authority of federal law in the future.

This Article reveals that there is still a significant aspect of AVs that have yet to be addressed. The technology promises the ability to program AVs beforehand so that we have a unique opportunity to reduce overall fatalities in the inevitable crashes. However, no state has enacted a provision on how AVs should behave in case of accidents.

This is similar to federal law, which provides no concrete suggestions for AV behavior in case of accidents. The minimal risk conditions defined by many states do not provide explanation or guidance for that question.

Further, some states may prohibit testing and operation of AVs if the vehicles do not comply with the rules, pose an unreasonable risk to the public, or are involved in a major accident. For example, the State of Arizona commanded an AV developer to suspend its testing of AVs after involving a fatal accident. This restrictive regulation would impede further development of AVs, as technological developments occur as a result of a trial-and-error process. This regulation is problematic because human drivers cause thousands of fatalities and are still allowed to drive on public roads, but AVs are not tolerated when they are involved in an accident. We would be better off in the long run if considerable number of failures of AVs would be tolerated in the short term to pave the way for a technology that promises to prevent more catastrophic failures.

State agencies may not have sufficient expertise and funding compared to their federal counterparts. Thus, their regulatory efforts could not extend to all complex and vital issues germane to AVs. However, this Article finds that inconsistencies between states are significant, and yet manufacturers prefer uniformity to comply with state law. Chris Urmson who was the head of the Google self-driving

524 COLO. REV. STAT. § 42-4-242 (3)(a); THE PENNSYLVANIA GUIDANCE, supra note 39, at 5; THE MASSACHUSETTS MEMORANDUM, supra note 42, at 6(b)(i); ARIZ. REV. STAT. § 28-9608.


526 See, e.g., Crane et al., supra note 128, at 204. (stating that a survey of the industry unambiguously revealed a consensus in favor of uniformity in regulatory approaches); Jessica S. Brodsky, Autonomous Vehicle Regulation: How an Uncertain Legal Landscape May Hit the Brakes on Self–Driving Cars, 31 BERKELEY TECH. L. J. 851, 874-75 (2016) (arguing that it is not possible for manufacturers to design an AV vehicle that can comply with each of fifty-one state laws and different state laws would impose unnecessary burdens on software developers who need to design complex software for each specific law); DARRELL M. WEST, SECURING THE FUTURE OF DRIVERLESS VEHICLES, BROOKINGS INST., (2016), https://www.brookings.edu/research/securing-the-future-of-driverless-cars (generally stating that the major difficulty is the regulatory environment caused by fifty different and conflicting state rules, which hampers innovation); US Urged to Establish Nationwide Federal Guidelines for Autonomous Driving, VOLVO CAR GROUP (Oct. 7, 2015), https://www.media.volvocars.com/global/en-gb/media/pressreleases/167975/us-urged-to-establish-nationwide-federal-guidelines-for-autonomous-driving [https://perma.cc/W46L-ZU5L] (warning by Volvo that the US risks its leadership in the development of AVs if it allows a patchwork of varying state laws and regulations).
car project stated that: "[i]f every state is left to go its own way without a unified approach, operating self-driving cars across state boundaries would be an unworkable situation and one that will significantly hinder safety, innovation, interstate commerce, national competitiveness and the eventual deployment of autonomous vehicles."527

Federal regulatory and legislative action would not only ensure safe and reliable testing and operation of AVs but also harmonization among states in the future. In any case, the states' efforts in regulating AV technology will provide valuable lessons for the rest of the world when start regulating AVs according to their national law.