1 **Potential Legal Barriers to Vehicle Automation in Virginia**
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29 *necessarily reflect the official policies or positions of any agency of the Commonwealth of*
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31

1   **ABSTRACT**
2   Technologies that allow computer-directed simultaneous operation of a vehicle's steering,
3   throttle, and braking continue to advance, with on-road manned testing ongoing in several states.
4   Vehicles able to operate with minimal or no input by a human driver are already operating on
5   low-speed private facilities, and may soon be technologically ready to drive on public roadways.
6   The legal status of automated vehicles is unclear, and—even in states with automated vehicle
7   legislation—there may be existing laws that inadvertently prohibit certain uses of automated
8   vehicles. This purpose of this paper is to identify potential legal barriers to vehicle automation in
9   Virginia, considering Title 46.2 of the Code of Virginia regarding motor vehicles, relevant case
10 law, and distracted driving ordinances of the twenty largest Virginia cities and counties by
11 population. The paper considers potential legal barriers to vehicles with conditional automation
12 (i.e. a human driver is available to intervene upon request), conditional automation with a human
13 driver remotely monitoring the vehicle's operation, and high automation without a human driver
14 present. The paper also considers the legality of certain automated vehicle sensing technologies,
15 as well as nonconventional vehicles such as sidewalk delivery robots, automated truck mounted
16 attenuators, and automated motorcycles. Virginia statutes, relevant case law, and ordinances that
17 may adversely affect the deployment of automated vehicles are identified. Lawmakers may wish
18 to use these as starting points for a full legal audit with respect to vehicle automation.
19

INTRODUCTION

Vehicles that simultaneously automate the steering, throttle, and braking tasks are currently being tested on public roads across the United States. Several automobile manufacturers including Volkswagen, General Motors, BMW, Ford, Toyota, Nissan and others have released statements saying they plan to have automated vehicles on the market by the early 2020s or sooner *(1)*. Small startups are developing technology to retrofit existing vehicles with automation capabilities *(2, 3)*, and one expects to have a kit available for sale as soon as January 2017 *(4)*.

While automated vehicle technology is rapidly developing, the statutes and regulations surrounding them are not. Five states (Michigan, California, Florida, Nevada, Tennessee) and the District of Columbia have enacted legislation specifically addressing automated vehicles *(5)*. Most of the regulations that permit automation require a human driver to remain in the vehicle to take control. Regulation becomes much more complicated

The most thorough analysis of the legality of various levels of vehicle automation in the United States was performed by Bryant Walker Smith in 2014 *(6)*. Smith analyzed the 1949 Geneva Conventions, the National Highway Traffic Safety Administration (NHTSA) regulations, and state vehicle codes. He concluded that while state vehicles codes "probably do not prohibit—but may complicate—automated driving," there remains a great deal of uncertainty about the legal status of advanced automation. In a later publication, Smith recommended that individual states perform legal audits and study how their own vehicle codes may apply to automated vehicles, both with and without a driver present *(7)*.

The objective of this paper is to identify potential legal barriers to vehicle automation in Title 46.2 of the Code of Virginia regarding motor vehicles, considering several levels of vehicle automation such conditional automation, remotely-monitored conditional automation, and high/full automation. This effort goes beyond Smith's work to investigate how Virginia's statutes may prohibit certain uses of nonconventional vehicles such as motorcycles, delivery robots, and automated truck mounted attenuators in rolling work zones. Finally, distracted driving ordinances in the twenty largest counties and municipalities in Virginia by population are reviewed for their potential effect on vehicle automation. This paper represents the most detailed analysis to date of the legality of automated vehicles within a single state, and will serve as a useful reference for policymakers as they begin to examine their legal codes in preparation for the arrival of automated vehicles.

DEFINITIONS AND BASELINE ASSUMPTIONS

Automated vehicles—referred to at various times as driverless, self-driving, autonomous, and robocars—are vehicles that can simultaneously control both lateral and longitudinal movement (i.e. brake, accelerator, and steering) within a range of scenarios and with various levels of required human oversight. Both NHTSA *(8)* and SAE International *(9)* have defined distinct levels of automation. The remainder of this paper uses the SAE definitions, of which the higher levels are summarized as follows *(9)*:

- **Partial Automation (SAE Level 2):** At least two primary control functions are designed to work in unison to relieve the driver of control of those functions. An example of combined functions enabling a Level 2 system is adaptive cruise control in combination with lane centering. A human operator is responsible for monitoring the automated system, and may receive no warning prior to a situation requiring intervention. Several

1   automated vehicles in existence today, such as Tesla's Autopilot *(10)*, are classified as
2   SAE Level 2.
3   • **Conditional Automation (SAE Level 3):** The automated system is responsible for
4   driving tasks as well as the monitoring of driving tasks. A human driver exists as a
5   fallback to the automated system, and may be required to intervene but only when given
6   adequate warning by the system.
7   • **High Automation (SAE Level 4):** The vehicle is designed to perform all safety-critical
8   driving functions and monitor roadway conditions in certain conditions and roadways.
9   Such a design anticipates that a human operator will provide destination or navigation
10   input, but is not expected to be available for control at any time during the trip, nor the
11   operator need be present inside the vehicle. The automated system is responsible for
12   determining when it is unable to drive, and to move to safety.
13 • **Full Automation (SAE Level 5):** The same as high automation, except the vehicle can
14   operate in all driving modes rather than in certain, limited conditions.
15
16   The greatest benefits of automated vehicles are expected to occur at Level 3, when
17 passengers are freed from monitoring the driving task and may use their time in other ways, and
18 at Levels 4 and 5, when vehicles may operate without a human present.
19
20 **The Vehicle as the Driver: NHTSA's Interpretation of Federal Motor Vehicle Standards**
21 On February 4, 2016, NHTSA's chief legal counsel Paul Hemmersbaugh responded to a letter
22 from the head of Google's Self-Driving Car project, Chris Urmson *(11)*. Google's original letter
23 had requested clarification as to whether Google's automated vehicle prototype could be
24 compliant with NHTSA's Federal Motor Vehicle Safety Standards (FMVSS). The complications
25 arose from the fact that Google's prototype was designed for high/full automation, with no input
26 required from the driver and therefore no steering wheel or foot pedals. Many NHTSA
27 regulations, however, refer to a "driver," an "operator," or "hand or foot control" for operating a
28 parking brake, suggesting the need for a human being sit behind a steering wheel. Google
29 specifically asked about NHTSA's definition of "driver" in 49 C.F.R. § 571.3 as "the occupant
30 of a motor vehicle seated immediately behind the steering control system." How could a human,
31 under this definition, ever "drive" a vehicle with no steering wheel? Could a computer or
32 artificial intelligence system be considered the driver instead?
33   NHTSA responded: "No human occupant of the SDV could meet the definition of
34 'driver' in Section 571.3 given Google's described motor vehicle design—even if it were
35 possible for a human occupant to determine the location of Google's steering control system, and
36 sit 'immediately behind' it, that human occupant would not be capable of actually driving the
37 vehicle as described by Google" *(11)*. NHTSA went on to note that if a human could not be the
38 driver, it would be "more reasonable to identify the 'driver' as whatever (as opposed to whoever)
39 is doing the driving" *(11)*. NHTSA concluded that, *in this example*, a piece of equipment or
40 system could be considered the driver.
41   Although widely-misinterpreted by the media as NHTSA claiming that a vehicle's
42 artificial intelligence would be considered a legal driver, it is clear from the context of the letter
43 that NHTSA is merely stating that a human *cannot* be the driver in Google's vehicle, and that,
44 for the sake of argument, NHTSA will use the assumption that the "self-driving system" could be
45 considered the driver for the purposes of responding to Google's letter *(12)*. NHTSA re-iterates
46 this point later, when noting that Google should apply for special exceptions while testing their

1 technology, and that NHTSA will "consider initiating rulemaking" to expand the definition of
2 driver to possibly include a "self-driving system" *(11)*. For further reading, see Smith's
3 discussion of "Nonhuman Persons Can Technically Be Drivers" *(6)*.
4   This paper employs a similar assumption to NHTSA's that, for the sake of argument, the
5 vehicle system itself could be considered a legal driver. This would require many changes to the
6 FMVSS, where 33 of the 73 standards either explicitly or implicitly assume a human driver *(13)*.
7 It might also require that states develop regulations for licensing vehicles, similar to how drivers
8 are licensed. Using this assumption, we reviewed statutes that were probably, but not always
9 explicitly, meant to apply to humans, and considered how these may prohibit the licensure or
10 operation of vehicles by a computer.
11
12 **Operator vs. Driver**
13 One of the largest legal issues that may affect many different aspects of automated driving is the
14 definition of operator or driver. The Code of Virginia § 46.2-100 defines the "operator" or
15 "driver" as "every person who either (i) drives or is in actual physical control of a motor vehicle
16 on a highway or (ii) is exercising control over or steering a vehicle being towed by a motor
17 vehicle." Although the Code of Virginia uses the terms "driver" and "operator" interchangeably,
18 these terms have been interpreted differently by courts.
19   There are several examples in case law where the term "operator" is defined more
20 broadly than "driver." In the case *Williams v. City of Petersburg*, the court held that "operating
21 includes starting the engine, or manipulating the mechanical and electrical equipment of the
22 vehicle without actually putting the car in motion. It means engaging the machinery of the
23 vehicle which alone, or in sequence, will activate the motive power of the vehicle" *(14)*. Under
24 this definition, operating includes starting the engine or manipulating the mechanical and
25 electrical equipment in any way. A person may be the operator simply by starting an automated
26 vehicle because automated systems are currently in control of the vehicle, the person may be
27 considered the operator because they initially engaged the vehicle. In a similar case, *Flournoy v.*
28 *State of Georgia* the court found that the intoxicated defendant who was found sitting under the
29 steering wheel of his automobile with the engine running but the vehicle not moving violated the
30 state's statute which makes it unlawful to operate or drive any motor vehicle when under the
31 influence *(15)*. The court held that "operate" has a broader meaning than driving and includes
32 "not only the motion of the vehicle but also acts which engage the machinery of the vehicle that,
33 alone or in sequence, will set in motion the motive power of the vehicle" *(15)*. The court found
34 that the defendants in both these cases were not controlling the vehicles in any way, but were still
35 considered the operators of the vehicles.
36   Extrapolating from these interpretations, a person in a automated vehicle who does not
37 drive the vehicle but engages with it to start the automated technology may be considered the
38 operator, even if they were never actually needed in the driving task. Laws that apply to
39 operators, such as prohibitions on driving while intoxicated (§ 18.2-266), might prevent an
40 intoxicated person from starting his or her automated vehicle. The use of "operator" in the Code
41 of Virginia and its broad definition in courts may lead to legal restrictions on the use of
42 automated vehicle technology even if the technology meets current or upcoming NHSTA
43 regulations. The impact of operator or driver on the different levels of automated vehicle
44 technology in the Code of Virginia is discussed in the sections below.
45

1 **LEGAL BARRIERS TO VEHICLE AUTOMATION IN VIRGINIA**
2 This paper addresses Virginia statutes that could potentially restrict or impact automated vehicles
3 in the different classifications of conditional automation (SAE Level 3)**,** remotely-monitored
4 conditional automation, high/full automation (SAE Levels 4 and 5), and other self-driving
5 technologies. Table 1 lists the sections of the Code of Virginia that may potentially conflict with
6 aspects of vehicle automation. An expanded table with full text of the statutes and explanations
7 is available online *(16)*. Distracted driving ordinances from the 20 largest counties and cities in
8 Virginia by population are included in Table 2.

9   **TABLE 1 Virginia Statutes Potentially Affecting Vehicle Automation**

Va. Code §	Summary
Definitions	
46.2-100	Operator or Driver is a person who drives or is in actual physical control of a vehicle.
Duties Requiring Human Presence	
46.2-104	Vehicle operator must possess a driver's license and registration and be able to display them. Operator must also "write his name in the presence of the officer" on request.
46.2-111	When a commercial vehicle is stopped, warning devices or flares must be placed in the road.
46.2-371	A driver involved in an injury accident must immediately report it.
46.2-894	If a driver of a vehicle is involved in an accident with unattended vehicle or property, they shall make reasonable effort to find the owner and leave a note and report the accident to the police.
46.2-1095	Any person who drives shall ensure that a child up to 8 is secured in a child restraint device.
Barriers to Licensing an Automated Vehicle	
46.2-300	A driver is required to obtain a license to drive in Virginia—an AV would require a license.
46.2-303	No license is required to operate a road roller or machinery used under VDOT maintenance.
46.2-310	Counties, cities, and towns may regulate licensing for taxicabs—may complicate AV taxis.
46.2-311	Drivers must pass a specific vision test to obtain a license.
46.2-322	DMV can require a physical examination as a part of licensing.
46.2-323.1	No driver's license will be issued to a nonresident. An AV would have to be considered a resident. Driver's license application shall include photograph of the applicant.
46.2-324.1	Driver's license shall not be issued unless applicant passed a behind-the-wheel examination.
46.2-325	Applicant's physical and mental qualifications can be examined before issuing a license.
46.2-328.1	A driver must be a citizen or legal permanent resident of the United States to obtain a license.
46.2-329	DMV may impose restrictions on licensee based on ability, or due to required special mechanical controls. Computerized control of vehicle may qualify as either.
46.2-334 to 334.02	Additional regulations for drivers (or AVs) under the age of 18
46.2-337	The DMV may provide special examination of motorcycles applicants.
46.2-341.14	Knowledge test may be written, verbal, automated or in foreign language without the use of interpreter. Applicants must be able to understand and respond to verbal commands in English during a skills test.
46.2-342	Licenses must include photograph, full name, date of birth, and address of the Licensee.
46.2-682.	No driver's license is required to operate a road roller or road machinery used under for VDOT maintenance.
Statutes Prohibiting Certain Automated Vehicle Uses	
46.2-341.24	It is unlawful for a person to driver or operate a commercial vehicle with a BAC of 0.08 percent or more. Deters intoxicated use of full-automation, as passenger may still be an operator.
46.2-804	It is illegal to drive to the left of a double traffic line unless to pass an obstruction or cyclist.
46.2-810	No person (or AV) under the age of 18 shall drive a vehicle used as a public passenger carrier.
46.2-812	No person (or AV) shall drive a vehicle for more than thirteen hours in a twenty-four hour period.
46.2-816	The driver of a vehicle shall not follow another vehicle more closely than is "reasonable and prudent." May prohibit automated vehicle platoons.
46.2-853	A person is guilty of reckless driving who drives a vehicle which is not under proper control.
46.2-855	A person is guilty of reckless driving if their view is obstructed or objects interfere with driver's control.
46.2-1010-16	A vehicle is operating under a special permit may have its top speed restricted.
46.2-903	No vehicle shall drive on the sidewalk other than wheel chair, bicycle, an electric personal assistive mobility device, or an electric power-assisted bicycle. Prohibits sidewalk delivery robots.

Va. Code §	Summary
46.2-904	Any county, city, or town may prohibit the use of any vehicle on sidewalks. Complicates sidewalk delivery robots.
46.2-1077	A television cannot be viewed by the driver while the car is in motion, exception for AVs.
46.2-1078.1	It is unlawful to operate a moving vehicle while using a handheld personal communications device to enter or read text.
46.2-1094	Any driver shall wear a safety belt at all times. This does not apply to drivers and passengers of taxicabs and persons with physician's approval. May require a self-driving system to wear a belt.
18.2-266	It shall be unlawful for any person to drive or operate any motor vehicle while under the influence of alcohol or drugs.
Unnecessary Equipment Requirements, Restrictions, and Regulations	
46.2-908.2	Low speed vehicles operating on the road shall be equipped with head lights, brake lights, etc.
46.2-910.	Person operating a motorcycle shall wear a face shield [other eye protection] or have a windshield.
46.2-912	Motorcycles headlights, horns, rearview mirrors are required under most conditions.
46.2-1005	The Superintendent may establish a procedure for the approval of equipment or wave the approval.
46.2-1010-16	Every vehicle driven in the Commonwealth shall be equipped with head, tail, and brake lights.
46.2-1019	Prohibits "spotlights" (headlights) directed left of the centerline or more than 100 feet ahead of the vehicle. Could be interpreted to prohibit LiDAR.
46.2-1033	Requires an high-beam indicator light.
46.2-1054	Requires unobstructed view through rear window, or side mirrors.
46.2-1055	Vehicles are required to be equipped with a windshield wiper.
46.2-1055.1	Vehicles are required to be equipped with a windshield defroster.
46.2-1057	Vehicles are required to be equipped with a windshield.
46.2-1059	Every vehicle driven on a highway shall be equipped with a working horn.
46.2-1065	Motor vehicles shall be equipped with steering gear adequate to ensure the safe control of the vehicle.
46.2-1068	Every motor vehicle, except motorcycles, shall be equipped with emergency or parking brakes. Unlike in some states, the emergency brake does not have to be foot actuated in Virginia.
46.2-1079	It is unlawful to operate a vehicle equipped with a device used to detect or purposefully interfere with or the measurement capabilities of law-enforcement personnel to measure the speed. Could prohibit radar sensing in automated vehicles, but seems unlikely.
46.2-1082	Vehicles are required to be equipped with at least one inside and one outside mirror.
46.2-1084	Vehicle is required to have a seat for the driver that permits him control over the steering and brakes.
46.2-1065	Recorded data may only be accessed by the motor vehicle owner or with the consent of the owner.
Inspections	
46.2-103	Officers can stop a vehicle to inspect its equipment. This could allow for officers to inspect AVs.
46.2-1158	Vehicles are required to be inspected every 12 months, could be expanded to include AV software.
46.2-1163	Superintendent may designate instructions for the inspection of motor vehicles.

10

11 **TABLE 2 Distracted Driving Ordinances of Twenty Largest Cities and Counties in**
12 **Virginia by Population**

County Ordinance	Title	Text
Fairfax County, Va., Municipal Code § 98-14	Failure to pay full time and attention	Drivers of vehicles shall at all times during the operation of such vehicle devote their full time and attention to such operation.
Alexandria, Va., Municipal Code § 10-3-3	Failure to give full time and attention.	No person shall operate a motor vehicle upon the streets of the city without giving full time and attention to the operation of the vehicle. Any person violating this section shall be guilty of a traffic infraction and punished by a fine of not more than $100.
Arlington County, Va., Municipal Code § 14.2-16	Operator to Give Full Time and Attention to Driving	No person shall operate a motor vehicle upon the highways of this County without giving his full time and attention to the operation of the vehicle.
Stafford County, Va., Municipal Code § 15-126	Drivers shall devote their full time and attention to driving	No person shall operate a motor vehicle upon any street, road, or highway in the county without giving their full time and attention to the operation of the motor vehicle. Any person violating this section shall be guilty of a traffic infraction. Any violation of this section shall be punishable by a fine of not more than five hundred dollars ($500.00).

13   The remainder of this paper discusses Virginia statutes affecting various levels and
14   aspects of vehicle automation. The discussion is organized into the following sections:
15   automated vehicle equipment, conditional automation with a human driver present, conditional
16   automation with a human driver remotely-monitoring one or more vehicles, and high/full
17   automation without a driver or passenger. Relevant case law is mentioned where applicable.
18
19   **Restrictions on Automated Vehicle Equipment**
20   Virginia has several laws that may prohibit the usage of certain sensors commonly found on
21   automated vehicles. For example, § 46.2-1019 requires that motor vehicles and motorcycles be
22   equipped with spotlights, but such that "no portion of the beam will be directed to the left of the
23   center of the highway at any time or more than 100 feet ahead of the vehicle." Many automated
24   vehicles use light detection and ranging systems (LiDAR) to determine distances to nearby
25   objects. LiDAR systems work by emitting non-observable light and measuring the reflection
26   time off various objects. While LiDAR emits light that is not observable to humans, it could still
27   potentially be classified as a lamp or spotlight under a strict interpretation of the spotlight
28   law *(6)*. This interpretation would restrict the use of LiDAR to less than 100 feet in front of the
29   vehicle and to the right of the center line. This would unnecessarily inhibit the coverage area of
30   LiDAR, and probably reduce the ability of the vehicle to detect and avoid objects.
31   Many automated vehicles use radar to detect and track objects. Radar is similar to
32   LiDAR, but uses radio waves instead of laser lights. Virginia is one on the few states United
33   States that prohibits the use of radar detection devices that purposefully interferes with law
34   enforcement speed detection devices (§ 46.2-1079). It seems unlikely that a court would interpret
35   automated vehicle radar technologies as "purposefully" interfering with law enforcement
36   activities, but it may still be useful to add an exception for automated vehicles.
37
38   **Restrictions on Conditional Automation**
39   One of the benefits of conditional automation (SAE Level 3, NHTSA Level 3) is that, by freeing
40   the human passenger from the responsibility of actively monitoring the roadway, the passenger is
41   able to pursue other tasks while in automated mode. Some existing laws in Virginia, however,
42   may limit the ways a passenger can use that time. For example, texting and driving is considered
43   a primary offense, and would be prohibited when operating a vehicle with conditional
44   automation (§ 46.2-1078.1). Not only is texting prohibited, but it is also unlawful to "manually
45   enter multiple letters or text in the device as a means of communicating with another person" and
46   "read any email or text message transmitted to the device or stored within the device" except for
47   contact information or caller identification. The restrictions apply to the person who is operates
48   the vehicle, and interpretation of the word "operate" is significant. In the Virginia case
49   of *Williams v. City of Petersburg*, the court defined "operating" as actions that include starting
50   the engine, manipulating vehicle equipment without putting the vehicle in motion *(14)*. Using
51   this interpretation, a person who starts the vehicle may be considered the operator (and therefore
52   prohibited from texting), even if the computer later takes over the driving task. This is just one of
53   example of how the term "operator" may need to be more clearly defined in regards to automated
54   vehicle operation.
55   Virginia legislators have already taken steps to allow for passengers of automated
56   vehicles to conduct other tasks while the vehicle is in motion. Virginia House Bill 454 *(17)*,
57   passed this year, created an exception in the Code of Virginia section on motor vehicles equipped
58   with televisions to allow for the viewing of a visual display while the vehicle is in automated-

59 mode (§ 46.2-1077). This change suggests that legislators understand passengers of automated
60 vehicles should be allowed to pursue other tasks while driving, but current Virginia statutes
61 prohibit many other useful tasks such as texting or typing on a computer.
62   There are also some restrictions in the Code of Virginia that seem unnecessarily
63 burdensome when applied to vehicle automation. One example is driving time limits, where a
64 person is limited to driving a motor vehicle for no more than thirteen hours in a twenty-four hour
65 period (§ 46.2-812). This restriction is presumably meant to limit driver exhaustion. Yet when
66 operating with conditional automation, the task of actively monitoring the roadway would be
67 performed by the vehicle, drastically reducing the mental load on the human and potentially
68 lengthening the amount of time that one could safely operate a vehicle.
69   Virginia also regulates the distance at which a vehicle may follow another vehicle,
70 prohibiting a driver from following "more closely than is reasonable and prudent" (§ 46.2-816).
71 Depending on how a "reasonable and prudent" headway is interpreted, this law may prohibit the
72 formation of automated vehicle platoons *(6)*, where automated vehicles organize themselves into
73 groups with short headways to minimize wind resistance and improve capacity. If the statute is
74 interpreted based on a human driver's conception of "reasonable and prudent," the 0.5 second
75 headways expected in automated vehicle platoons may be illegal. If instead, the law is
76 interpreted as "reasonable and prudent" by computer-driven vehicle standards, then platoons may
77 be considered legal.
78
79 **Restrictions on Remotely-Monitored Conditional Automation**
80 A rarely discussed automated vehicle deployment scenario involves a single licensed driver
81 responsible for monitoring a vehicle with conditional automation from a remote location. An
82 automobile was first controlled via radio by an operator in a following vehicle in 1925 *(18)*, and
83 recent advancements in video allow the operator to be completely off-site, as demonstrated in
84 mining operations *(19)* and drone warfare *(20)*. By applying this technology to passenger
85 vehicles, a licensed driver could remotely monitor a vehicle with conditional automation, and be
86 available to take (remote) control given adequate warning.
87   Remote control could occur in a range of ways. In one example, a construction vehicle in
88 an active work zone could be controlled by a worker standing in safe location along the shoulder.
89 In a more complex example, a licensed driver in India could monitor five automated taxis in the
90 U.S., interceding when requested. (A team of drivers would be needed in the last example, to
91 provide a backup in case two of the five taxis request assistance; a team of five drivers
92 monitoring 25 vehicles would probably be adequate.) Such a system would drastically reduce the
93 costs of operating a taxi, transit, or delivery service, without the need for high/full automation.
94   There is some ambiguity regarding whether a licensed driver can legally operate a vehicle
95 from a remote location. The definition of "driver" and "operator" in Virginia refers to one who
96 "drives or is in actual physical control of a motor vehicle on a highway" (§ 46.2-100). While this
97 does not explicitly require one to be physically present in the vehicle in order to drive it, there
98 are other statutes that seem to suggest physical presence is assumed. For example, if requested
99 by a law enforcement officer, an operator must "write his name in the presence of the officer" in
100 order to establish identity (§ 46.2-104). If interpreted strictly, this does not seem to permit any
101 type of wireless transmission of a signature. Section 46.2-111 requires an operator of a
102 commercial vehicle, within ten minutes of stopping, to "place or cause to be placed on the
103 roadway or shoulder three red reflectorized triangular warning devices" up to 100 feet away from
104 the vehicle(§ 46.2-111). An advanced automated truck may be able to carry some type of

105   smaller, flare-dispensing robot capable of traveling 100 feet as a way to meet this requirement,
106   but otherwise this statute would make teleoperation fairly difficult.
107   Case law gives some insight into the potential legality and restrictions to remotely
108   monitored vehicles. In *John Terry Dugger v. Commonwealth of Virginia*, the court held that an
109   intoxicated passenger who took temporary control of a vehicle while sitting in the passenger seat
110   could be considered an operator of the vehicle *(21)*. In *Leake v. Commonwealth of Virginia*, the
111   court found that one could be operating a vehicle while standing on the road but leaning into the
112   passenger side of a parked, running car *(22)*. Extrapolating, one could argue that if a driver does
113   not have to be in the driver's seat, they may not to be in the vehicle at all. The legality of remote
114   operation, however, remains far from certain.
115
116   **Restrictions on High/Full Automation without a Human Driver**
117   Many of the legal issues that affect conditional automation also affect high and full automation,
118   especially when carrying a passenger. This section focuses on statutes that affect full/high
119   automation due to the lack of any driver, either physically present or remotely monitoring the
120   vehicle.
121
122   *Unique Legal Restriction for High/Full Automation*
123   There are some unique legal issues vehicles with high/full automation capabilities face beyond
124   those affecting vehicles with conditional automation. One example is laws prohibiting driving
125   while intoxicated. In 2014, alcohol-impaired driving resulted in 31 percent of the total driving
126   fatalities in the United States *(23)*. The promotion of high/full automation as an alternative to
127   driving under the influence (DUI) could help to significantly reduce the number of DUI crashes
128   in Virginia, but the use of highly automated vehicles while under the influence may be prohibited
129   under current Virginia law. It is illegal in Virginia for any person to operate a motor vehicle
130   while under the influence of alcohol or drugs that impair the ability to drive or operate a vehicle
131   (§ 18.2-266). Even though a person in the highly or fully automated vehicle has no expectation
132   of intervening in the driving task for any reason, as per the definitions of SAE Levels 4 and 5 *(9)*,
133   under current law one might still be in violation, as the passenger may be considered the
134   vehicle's operator by initiating the vehicle, and because it is illegal to "drive or operate" a
135   vehicle while under the influence (§ 18.2-266). Without a distinction between "operate" and
136   "drive," current DUI laws might prohibit one of the most significant benefits of highly
137   automated vehicles.
138
139   *Licensing Vehicles with High/Full Automation*
140   Licensing is complex a legal issue automated vehicles face in Virginia. A vehicle with high or
141   full automation requires no driver feedback and can operate without a person inside the vehicle.
142   Governments may decide that the vehicle systems themselves are effectively drivers, and as
143   such, these systems would be required to obtain some form of driver's license.
144   Under existing laws, it would be fairly difficult for an automated vehicle (or its parent
145   company) to obtain a driver's license. Virginia licensing laws require that a person applying for a
146   license be at least 16 years and three months old (§ 46.2-334), be a resident of Virginia (§ 46.2-
147   323.1), pass a driver education course or behind the wheel examination (§ 46.2-325), be able to
148   take and pass a physical knowledge examination without the use of an interpreter (§ 46.2-325),
149   and be able to provide identification information (§ 46.2-342). Some of these requirements
150   would be easy for an automated vehicle or corporation to meet, some impossible, and some

151 nonsensical *(6)*. Licensing laws and regulations will probably need to be revised in order to
152 accommodate vehicles with high/full automation.
153   One important social benefit of highly automated vehicles is that they do not require a
154 driver to be available for control, and could therefore provide increased access and mobility for
155 the disabled, elderly, and children *(24)*. Virginia prohibits any person from driving any motor
156 vehicle unless they have obtained a driver's license and passed the drivers examination. The law
157 does not prohibit the *operation* of motor vehicles by unlicensed drivers, but only makes it illegal
158 to *drive* any motor vehicle (§ 46.2-300). As explained in an earlier section on the different
159 interpretations of operator vs. driver, a person may considered the operator of a vehicle if he or
160 she engages with the vehicle in any way. If a vehicle with high automation becomes a licensed
161 *driver*, this may allow an unlicensed person to *operate* (i.e. initiate and then ride in) the vehicle
162 while in autonomous mode, similar to requesting a taxi.
163
164 *Laws that Imply or Assume Human Presence*
165 Some statutes require the driver to do things that imply or assume that a physical person is
166 present in the vehicle. In the event of a crash involving an unattended vehicle or property, the
167 driver is required to use reasonable effort to find the owner of the property and report the
168 accident or to leave a note with driver identification and contact information and then also to
169 report the accident to the police (§ 46.2-894). It would be difficult or impossible for an
170 automated vehicle to leave a note or its driver information in the event of a crash, although
171 contacting law enforcement may be adequate.
172   Automated commercial vehicles would also be required to complete some driver tasks
173 difficult or impossible for a computer. In the event that an automated commercial vehicle was
174 forced to stop on the road, it is required to immediately activate the hazard lights and within 10
175 minutes of stopping to place reflector warning devices on the road (§ 46.2-111). Without some
176 type of technological solution (e.g. a flare-deploying robot), a driverless automated vehicle
177 would have difficulty meeting this requirement.
178
179 *Vehicle Equipment Requirements*
180 Some vehicle equipment standards may become unnecessary or difficult to comply with when
181 the vehicle itself is considered the driver. Regulations that assume a human and his or her
182 capabilities in the FMVSS are beginning to be identified *(13)*. Several Virginia statutes also
183 require equipment that may complicate the design and operation of highly automated vehicles.
184   Vehicle equipment requirements make it unlawful for any person to drive on a highway
185 any vehicle unless it is equipped with a windshield with an unobstructed view (§ 46.2-1057),
186 mirrors (§ 46.2-1082), and windshield wipers (§ 46.2-1055), all of which may be useless to an
187 automated vehicle's video, sonar, radar, and LiDAR sensors.
188   Virginia also has specific requirements for seats for the driver. It is unlawful for a person
189 to drive a vehicle unless it is equipped with a seat for the driver located so the driver can
190 adequately control the steering, braking, and other mechanisms for safe operation of the vehicle
191 (§ 46.2-1084). This law may require that the computer or system that is the car's driver may need
192 its own seat. There's no explicit requirement that the driver sits in the seat while driving, which
193 may allow the computer to control the vehicle while not physically in a seat or in contact with
194 the controls of the vehicle as long as there is an empty seat located within the to permit adequate
195 control of steering and braking. This law, while not overly burdensome, does introduce some
196 design challenges for industry.

197   Driver safety belt law may also be difficult to adhere to. If the computer or system is
198 considered the driver, it would be impossible (or at least awkward) for it to wear a safety belt.
199 While Virginia requires that any driver shall wear the appropriate safety belt system at all times,
200 an exception is given when a licensed physician determines that a safety belt would be
201 impractical because of physical condition (§ 46.2-1094). Seat belts are also not required for
202 drivers and passengers in taxicabs. The medical exemption seems unlikely to apply for an
203 automated vehicle, but an automated taxi could avoid the seat belt requirements as currently
204 written.
205
206 *Driving Time Limits*
207 The restriction on driving time of no more than thirteen hours in a twenty-four hour period (§
208 46.2-812) would be unnecessarily burdensome for a vehicle with high/full automation. An
209 automated vehicle that is driving is not subject to mental fatigue, and would not require 11 hours
210 of rest each day. An automated vehicle might be able to work around the restriction by installing
211 two separate self-driving systems in each vehicle, and alternating them so that neither exceeds
212 the thirteen hour limit. This might be feasible if the self-driving system were defined as
213 consisting of a fairly inexpensive of self-contained piece of hardware, but would be much more
214 difficult if the self-driving system is more complicated or expensive. A simpler approach may be
215 to specify that this law does not apply to highly-automated vehicles.
216
217 **Nonconventional vehicles**
218 Other developing automated technologies that may face legal restriction in Virginia include
219 sidewalk delivery robots, automated motorcycles, and automated truck mounted attenuators.
220
221 *Delivery Robots*
222 Delivery robots are small, driverless, low-speed wheeled robots designed to deliver small
223 packages to homes and businesses. Prototypes are typically two-feet high with a locked
224 compartment that can only be opened by the recipient with an access code or recognized phone
225 *(25)*. Unlike most automated vehicles, delivery robots are designed to operate on sidewalks, but
226 may occasionally use low-speed, low-volume residential streets. These vehicles are expected to
227 drastically reduce the cost of the "last mile" problem of package delivery, where the final stage
228 of delivery requires a disproportionately greater cost.
229   Unlike roadways, where vehicles are generally allowed unless explicitly prohibited,
230 sidewalk use is prohibited by any vehicle except "(i) an emergency vehicle, as defined in § 46.2-
231 920, (ii) a vehicle engaged in snow or ice removal and control operations, (iii) a wheel chair or
232 wheel chair conveyance, whether self-propelled or otherwise, (iv) a bicycle, (v) an electric
233 personal assistive mobility device, or (vi) an electric power-assisted bicycle on the sidewalks of
234 any county, city, or town of the Commonwealth" (§ 46.2-903). Unless delivery robots are
235 included as an exception, or they are classified as one of the allowed classes, they would be
236 prohibited from using all sidewalks in Virginia.
237   A similar challenged was faced by the creators of the self-balancing Segway when their
238 device was first introduced. To allow the use of Segway, most states defined a new vehicle
239 class—"electric personal assistive mobility device" in Virginia (§ 46.2-100)—and changed their
240 sidewalk laws to allow these vehicles. A similar approach could be used for delivery robots.
241

242   *Motorcycles*
243   At the 2005 DARPA Grand Challenge, a competition for autonomous vehicles to traverse a
244   section of desert with no human input, one of the (unsuccessful) entrants was a motorcycle *(26)*.
245   While there has been relatively little research into automation of two-wheeled vehicles since
246   then, at least one manufacturer has announced plans to develop an automated motorcycle *(27)*.
247   In Virginia, a motorcycle is defined as a motor vehicle with up to three wheels that is
248   capable of traveling at speeds exceeding 35 miles per hour, while an autocycle is defined as a
249   three-wheeled vehicle with a steering wheel that does not require the operator to straddle the seat
250   (§ 46.2-100). (The autocycle, while not a motorcycle, appears to be a vehicle class somewhat
251   unique to Virginia, and was introduced in 2014 in response to a local company manufacturing
252   the novel three-wheeled vehicles *(28)*.)
253   Motorcycles and autocycles are required to meet some driver and equipment
254   requirements that may be difficult or not beneficial for automated motorcycles to meet. A person
255   operating a motorcycle or autocycle is legally required to wear safety glasses, or have the vehicle
256   equipped with a windshield (§ 46.2-910). This requirement may no longer make sense under
257   high/full automation, as passengers on motorcycle and autocycles are exempt from the goggle
258   requirement presumably because they would not have to take control.
259   Motorcycles and autocycles are also required to headlights, horns, and rearview mirrors
260   (§ 46.2-912). While headlights and horns will be required for the safe operation of automated
261   motorcycles for the foreseeable future, other equipment such as mirrors may be unnecessary
262   under high/full automation.
263   Rider position requirements may also prevent the use of automated motorcycles. Section
264   46.2-909 states that "Every person operating a motorcycle, as defined in § 46.2-100, excluding
265   three-wheeled vehicles, shall ride only upon the permanent seat attached to the motorcycle,
266   unless safety dictates standing on both footpegs for no longer than is necessary." Given the new
267   definitions of "operating" explored in this paper, this law could prevent the operation of
268   automated motorcycles. For example, a person remotely-operating a vehicle would be unable to
269   simultaneously ride on the seat. Also, a passenger who is operating a highly/fully automated
270   motorcycle would be prohibited from riding on the passenger seat or in a sidecar.
271
272   *Automated Truck Mounted Attenuators (ATMAs)*
273   Another developing technology that may greatly benefit construction workers in Virginia is
274   automated truck mounted attenuators (ATMAs). Tuck mounted attenuators (TMAs) describe a
275   construction vehicle mounted with a rear-facing device meant to absorb the energy of an errant
276   vehicle. These are often positioned upstream of a work zone, or as the rear-most vehicle in a
277   rolling work zone. Although they are often stopped or traveling at low speeds, TMAs require
278   human drivers, who are then exposed to traffic and the risk of injury—a study in New York
279   found that of 27 TMA crashes, seven resulted in injuries to the TMA driver *(29)*. The risk to the
280   TMA driver could be eliminated by using fully automated TMA (ATMAs) trucks, or by
281   operating the TMA by remote control. At least one manufacturer is marketing a driverless
282   ATMA which uses integrated sensors to follow a lead construction *(30)*.
283   Although it is illegal to drive without a license in Virginia (§ 46.2-300), an exception is
284   made for those operating road machinery used for Department of Transportation construction or
285   maintenance purposes (§ 46.2-303). It's permissible to drive these vehicles (called "road
286   machinery" on the roadway without a license (examples of which are provided in §§ 46.2-663
287   through 46.2-674. These sections list several types of construction equipment, but TMAs are not

288   included. The law goes on to clarify that "the term 'road machinery' shall not include motor
289   vehicles required to be licensed by the Department of Motor Vehicles" (§ 46.2-303). ATMAs,
290   which are generally registered with the DMV, would appear to be excluded from the term "road
291   machinery" and would therefore still require a human driver.
292
293   **CONCLUSION**
294   Vehicle operation is becoming increasingly automated, yet the legal environment surrounding
295   vehicle automation remains uncertain. States will be responsible for vehicle inspections,
296   licensing drivers, regulating the operation of behavior of vehicles on public roadways, and,
297   should the vehicle itself be classified as a driver, states may also be responsible for licensing
298   vehicle technology itself. Although advanced levels of vehicle automation will likely require
299   new regulations, the first step in preparing for a new technology is to assess how existing law
300   may affect its use and development.
301   This paper identified several instances where existing laws in Virginia may
302   unintentionally prohibit certain technologies or uses of automated vehicles. The authors
303   investigated the Code of Virginia addressing motor vehicles, relevant case law, and distracted
304   driving ordinances of the twenty largest cities and counties in Virginia by population. The
305   authors found 56 statutes that adversely affect or create uncertainty around automated vehicle
306   equipment, types, and uses. Future research should include a thorough legal audit, reviewing
307   both statutes and regulations, not only as they may affect motor vehicles, but also as they may
308   affect businesses, the use of different facility types, and insurance.
309
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313
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