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Statement
of the
National Association of Mutual Insurance Companies
to the
United States House of Representatives
Subcommittee on Consumer Protection and Commerce of the
Committee on Energy and Commerce
hearing on
Autonomous Vehicles: Promises and Challenges of Evolving
Automotive Technologies
February 11, 2020

The National Association of Mutual Insurance Companies ("NAMIC") is pleased to offer comments on the House of Representatives Subcommittee on Consumer Protection and Commerce of the Committee on Energy and Commerce United States Senate Committee on Commerce, Science, and Transportation on the promises and challenges of evolving automotive technologies.

NAMIC is the largest and most diverse national property/casualty insurance trade and political advocacy association in the United States. Its 1,400 member companies write all lines of property/ casualty insurance business and include small, single-state, regional, and national carriers accounting for 50 percent of the automobile/ homeowners' market and 31 percent of the business insurance market. NAMIC has been advocating for a strong and vibrant insurance industry since its inception in 1895.

The development of Automated Driving Systems (ADS) may be the most consequential transportation issue of our time. New technology and novel service strategies promise faster and better mobility that will be less expensive, and more environmentally friendly. Spring boarding from existing and widely accepted "assisted driving" systems such as cruise control, ADS developers promise a wider array of functions from greater driver assistance to vehicles that will perform every driving operation with no human intervention.

Safety Must Be the Primary and Overriding Focus

The single most important reason to support the development of ADS is the potential to enhance safety and save lives. While the idea of working, napping, or watching a movie while the car drives itself may be enticing to many, enhanced safety must always be the primary focus of ADS development. ADS that are proven safer than existing drivers will have innumerable benefits to society. However, the development and deployment of proven, safe ADS will require significant technological advances, revisions to the regulatory paradigm, and the active participation of all the stakeholders.

The potential for technology to move the needle on crash statistics is extraordinary; however, there will still be crashes, especially in an environment where autonomous vehicles continue to share the road with human drivers. It is important to note that ADS, in and of themselves, do not fundamentally change the legal theories of liability associated with motor vehicle crashes. As these ADS crashes happen and questions of liability arise, insurance will play a crucial role for ADS manufacturers, suppliers, owners, operators, and passengers.

Safety must be the primary goal for ADS development but defining and proving what "improved safety" means for ADS is not simple. Currently, federal auto safety regulations focus more on the structure and design of vehicles and less on the driving operations that are subject to human control. With ADS, the vehicle will assume driving operations formerly performed by the human driver. Thus, the safety responsibilities of the vehicle will expand and will continue to expand until the vehicle assumes all driving operations without any human control. On the one hand, most car crashes involve driver error and ADS promises computer systems that will not replicate the conditions that lead to those errors — i.e. sleeping, intoxication, distraction, or speeding.

According to the NHTSA, "Fully automated vehicles that can see more and act faster than human drivers could greatly reduce errors, the resulting crashes, and their toll." On the other hand, the elimination of certain human errors does not tell us anything about the introduction of computer, sensor, or software error. Safe ADS will require a substantial amount of specialized software, sensors, controllers, and actuators to collectively perform without error, or at least as well as those human drivers, the large universe of operations that human drivers already perform. The bar for performance has been set high: human drivers in 2017 averaged 500,000 vehicle miles between crashes, more than one million vehicle miles between crashes with an injury and nearly 100 million vehicle miles between fatal crashes. [1]

The development of ADS will require a new way to look at the fundamental nature of driving, and that development should not be hindered by requiring outdated safety requirements that do not apply to new technologies. At the extreme end of the spectrum, the development of ADS with no driver controls will mean that vehicle features that are now required for human operation may not be necessary or practical. Sound policy should include a review of which requirements would no longer be relevant for a fully autonomous vehicle. The Federal Motor Vehicle Safety Standards (FMVSS) are the U.S. federal regulations specifying nationwide design, construction, performance, and durability requirements for auto-safety-related components, systems, and design features.

FMVSS focus mostly on crash avoidance, crashworthiness, and crash survivability. Existing FMVSS specify that controls and displays must be located where they are visible to or within the reach of a person sitting in the driver's seat. Depending on whether the occupants have "dual mode" or no control of an ADS, there may not be a "driver's seat" or the relevant controls or displays of driving operations may vary with the driving operations that the human retains. In various iterations of ADS, auto parts subject to FMVSS such as rearview mirrors may or may not be superfluous for driving operations. Similarly, controls for turn signals, lights, or wipers may or may not be required and may or may not be subject to safety standards.

The focus must remain on ensuring that critical safety aspects are examined and validated and that any safety assurance gaps that may be created by the introduction of ADS onto the roads are identified and addressed. This is far more complicated than it may seem. While many human-driver focused FMVSS do not make sense for ADS, perhaps ADS-specific safety tests should accompany broad exemptions. Existing self-certification should be supplemented by governmentally defined and publicly disclosed standards and then supplemented by third-party validation of design and testing.
Pre-market approval has many downsides, but some level of independent ADS safety review could supplement self-certification.

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[1] US Department of Transportation Bureau of Transportation Statistics https://www.bts.gov/content/motor-vehicle-safety-data

The State of Automated Driving Systems Today

As more completely defined in the NAMIC 2019 white Paper *Responsibility Assessment Standards For Conditional Automation/Dual Control Vehicles*, attached hereto as an Appendix, today, and possibly for a long time to come, the full driving task – SAE Levels 4 and 5 – is too complex an activity to be fully formalized as a sensing-acting robotics system that can be explicitly solved through model-based and learning-based approaches in order to achieve full unconstrained vehicle autonomy.[2] Car companies – or original equipment manufacturers, as they are known – are building and offering cars today in which the dynamic driving tasks of the vehicle can be controlled at times by the vehicle and at times by the occupant. These conditional automation/dual-control cars can be as relatively simple as the widely used automatic braking.

In November 2019 testimony before the United States Senate Committee on Commerce, Science, and Transportation, Robert Sumwalt, board chairman of the National Transportation Safety Board, noted that one of the main sources of confusion in discussions about AVs is the language used in the auto industry and by researchers and regulators compared to what is used by the general public. Industry, regulators, and academics frequently use the six-level SAE automation taxonomy as a reference point when discussing vehicle capabilities and operator responsibilities, but Sumwalt maintained that the SAE automation levels may not be easily relatable to the general public, and the terms used by vehicle manufacturers to market their partial-driving automation systems can add to public confusion about the degree of automation in the production-level vehicles now available.[3]

Advanced driving assistance features today specify that they do not substitute for the driver's responsibility to operate the vehicle in a safe manner; that the driver should remain attentive to traffic, surroundings, and road conditions at all times; and that visibility, weather, and road conditions may affect feature performance. Additionally, some of the driving automated systems offered today have proven to be far less effective than advertised.[4] Although much attention and federal effort have been focused on highly automated SAE Level 3–5 vehicles, NTSB's Sumwalt advised that of equal and more immediate concern should be the current deployment of partial-driving automation systems on our nation's highways.[5]

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[2] Citing MIT Advanced Vehicle Technology Study: Large-Scale Naturalistic Driving Study of Driver Behavior and Interaction with Automation, available at https://arxiv.org/pdf/1711.06976.pdf .

[3] Testimony of The Honorable Robert L. Sumwalt, III, chairman, National Transportation Safety Board, before the Committee on Commerce, Science, and Transportation,
United States Senate hearing "Highly Automated Vehicles: Federal Perspectives on the Deployment of Safety Technology," pages 1-2 at https://www.commerce.senate.gov/services/files/B8EF39B5-DE24-48AA-A870-B6CF8E0D5033 .

[4] Automatic emergency braking systems with pedestrian detection technology in some late model vehicles perform inconsistently and proved to be completely ineffective at night,
new 2019 research from AAA reveals. https://midatlantic.aaa.com/public-affairs/press-release/?Id=84ff9a4f-e645-41eb-92a9-cbf479ba1eb6

[5] Sumwalt testimony, page 5.

The overriding challenge of these dual controlled automated/operator vehicles is that a human occupant will be required under varying conditions to assume control under expected conditions, such as leaving a highway to small side roads, as well as under emergency conditions. One of the major perceived benefits of automated vehicles is enabling occupants to be partially disengaged from the driving operations, allowing them to rest, relax, or perform other functions. They are only partially disengaged because control of the vehicles can and will be handed over to them in defined and emergency situations. This will require that the human driver, perhaps engaged in non-driving activities, remain vigilant to driving conditions. Either people disengaged from the driving task must resume control of the vehicle immediately, or a safe and reliable "handover" system must exist to retain control and then turn driving operations to a human. This handover situation is widely regarded as the most dangerous, and how and when this handover period operates will vary from function to function and from vehicle to vehicle.

As further detailed in the white paper, the lack of any standards or common understanding of dual control vehicle capabilities and limitations greatly increases safety risks. The respected Insurance Institute for Highway Safety (IIHS) has found that mismatches among a designer's intent for how systems should be used, what the interfaces should communicate to drivers about those systems, and how drivers should use that information when operating the vehicle result in driver misuse and overreliance on the systems.[6]

The Challenge: Defining What Dual Control Automated/Driver Vehicles Can DO and Cannot Do

It is important to understand the designed capabilities and limitations of the dual control vehicle and how and when driving operations were engaged or disengaged leading up to the crash. NTSB Chair Sumwalt as stated, "As more manufacturers deploy driving automation systems on their vehicles, to improve system safety, it will be necessary to develop detailed information about how the active safety systems performed during, and how drivers responded to, a crash sequence. Manufacturers, regulators, and crash investigators all need specific data in the event of a system malfunction or crash."[7]

One the biggest impediments to the deployment of dual control vehicles is public wariness of automated vehicles, which, based on recent studies, public confidence in "self-driving" cars is low.[8] Providing more specific information about what each

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[6] Effects of training and display content on Level 2 driving automation interface usability, available at https://www.iihs.org/topics/bibliography/ref/2191

[7] Sumwalt testimony, page 9

[8] A 2019 Reuters/Ipsos poll found half of U.S. adults think automated vehicles are more dangerous than traditional vehicles operated by people, and more than 60 percent of respondents would not pay more to have a self-driving feature on their vehicle. Americans still don't trust self-driving cars, Reuters/Ipsos poll finds, at https://www.reuters.com/article/us-autos-selfdriving-poll/americans-still-dont-trust-self-driving-cars-reuters-ipsos-poll-finds-idUSKCN1RD2QS . A 2018 poll by J.D. Power and NAMIC found that 42 percent said they would never ride in a fully automated vehicle. AAA reports that more than 70 percent of Americans are afraid to ride in a self-driving car,

model of dual control vehicle is designed to do will enable consumers to better understand and accept their responsibilities in these vehicles. Again, as detailed further in the white paper, Increasing confidence in the technology through access to more and better information of specific capabilities and limitations of a vehicle could enhance the safe operation of these vehicles and prepare consumers for higher levels of automation in the future. This same information can greatly assist the further development and implementation for clear federal and state regulations for the deployment of these vehicles. By making this information widely available without government regulations, OEMs can provide regulators with the assurances they need but retain the flexibility to modify disclosures to address upgrades and revisions. False or misleading information will remain subject to existing civil and criminal sanctions.

Insurance Companies Have the Expertise to Address the Challenge of Assessing the Safety Testing of Automated Vehicles

Insurers have long championed auto and highway safety issues and have helped raise public awareness through the creation and ongoing support of auto safety research organizations such as the Insurance Institute for Highway Safety and the Highway Loss Data Institute. The Insurance Institute for Highway Safety is an independent, nonprofit scientific and educational organization dedicated to reducing the losses — deaths, injuries and property damage — from motor vehicle crashes. The Highway Loss Data Institute shares and supports this mission through scientific studies of insurance data representing the human and economic losses resulting from the ownership and operation of different types of vehicles and by publishing insurance loss results by vehicle make and model. Insurers have allied with safety groups to work together to make America's roads safer.

The critical issues related to passenger safety, liability, and recovery after a crash require that insurance companies are included in the development, deployment, regulation, and use of ADS, including any NHTSA research program. Consumers will continue to look to property/casualty insurers to provide them with the protections they have come to expect as this new frontier of automotive products and services evolves. A 2018 JD Power survey found that consumers have the highest levels of confidence in insurance dealing with ADS.[9]

The business of insurance demands that it applies hard data and institutes actuarial science to assess and mitigate risk. It was more than 30 years ago that coalitions of insurance companies together with consumer groups first favored state requirements for seat belts and air bags and opposed the auto makers reluctance to provide such safety features.

Insurers have a long and proven history of working hand-in-hand with regulators and auto manufacturers to facilitate developments that save lives and prevent injuries and damage. The revolutionary replacement of the human driver with ADS

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an increase from 63 percent in 2017. Three in Four Americans Remain Afraid of Fully Self-Driving Vehicles, at https://newsroom.aaa.com/2019/03/americans-fear-self-driving-cars-survey/.

[9] Automated Vehicles and Insurance Pulse Survey, https://www.namic.org/pdf/18memberadvisory/181008_Automated_Vehicles_JD_Power_NAMIC_Questionnaire.pdf

will require auto insurers to understand each vehicle's design and operation. Ultimately, drivers may not be comfortable with "dual mode" or no control whatsoever, which means that the insurer of that human driver must fully understand the planned automated driving operations as well as any possible human operation of the vehicle under any circumstances.

The insurance industry understands that new and different data will be needed for insurers to write ADS-related insurance policies. The extensive history and level of human driving data that insurers have developed must now be supplemented by increasingly complex data on the automated driving systems that assist or replace those human drivers. Insurers have a proven record of assessing driving risks and communicating to auto owners the methods to mitigate that risk.

Defining and Analyzing the Appropriate Safety Data is Critical

Insurers should have access to a robust ADS information and data framework – including crash accident and incident information and data for businesses purposes including underwriting and rating – that is timely, complete and useful. It is critically important for Congress to address these issues when writing any legislation for the development and deployment of automated vehicles.

The types of objective and verifiable data that will be required to provide insurance for ADS — data on frequency, severity, and repairs — are the same types of data that can authoritatively validate safety levels of ADS to the public and regulators. Auto insurance rates and coverage are established by insurance companies using vast amounts of historical data and established actuarial science, analyzing years of relevant data on frequency and severity of incidents. The rates determined by insurance companies are then frequently subject to a review by the state insurance regulators to ensure that they are fair and supported by data.

Valid and understandable data on ADS is critical to safety. The development and deployment of ADS — particularly the proposed ADS with "dual mode" or no controls for a human driver — is a game changer. It will entail a fundamental change in transportation, mobility, infrastructure, and myriad other areas. The adoption of ADS on a wide scale will impact millions of people and will require adaptation by governments, industries, and the culture in general. The precondition to this development is an accepted belief that ADS improve safety, which will itself require sufficient data and information upon which to validate that belief. To date, information about ADS development in general and safety specifically has been limited.

ADS development is still in the early stages and myriad business, design, technical, and other issues are still only being discussed. In the competition to bring ADS to market, there should be a requisite level of confidentiality. Insurance companies understand confidential information and have a long history of working with auto companies to obtain and use available data. Similarly, insurance companies have deep experience in data security and the wide scope of data privacy requirements.

At the same time, there is a significant level of concern that this system of voluntary self-certification by manufacturers of the safety of ADS may not be adequate to enable the development and public acceptance of safe ADS. Having defined and transparent government standards will result in more and better data and information on ADS that will help its development, the understanding and acceptance by the public of ADS, and the development of related businesses like insurance that will be critical to ADS use.

It would be in the best interests of proponents of safe ADS to coordinate and consider new and improved alternatives to communicate on ADS technology and performance. Somewhere between the extreme poles of "just trust us" and reams of federal regulations requiring submission of millions of certified data points is a system of information and communication that is usable and comprehensible for the public, governments, and other industries. Validation of safe ADS development and a resulting public acceptance can be greatly enhanced by a measurable gauge of ADS safety/risks through recognized analysis of most relevant data. Insurers, with their direct and ongoing contact with drivers and owners, are a most effective way to enhance that communication.

Conclusion

The insurance industry has continuously proven its commitment to supporting the development and deployment of real auto safety benefits at the earliest time. For ADS, these benefits are dependent, however, on many and daunting technological, logistical, and regulatory revisions that remain to be designed and successfully implemented. The existing environment of auto safety regulation evolved with a human-driver focus and has not fully considered the many nuances of increased assisted and automated driving systems. As these systems develop and evolve, the risk of regulatory safety gaps increases and the need for a comprehensive reassessment of driving operation safety grows exponentially, staffing with the paramount focus on the safety of vehicle occupants, occupants of other vehicles, and the public.

For the public to understand and accept ADS safety developments[10], we must show how we got to the answer; to illustrate the exact steps taken to achieve specific metrics of safety for ADS. Broad assurances of overall safety must be bolstered by facts and data on ADS design and operation. Third party validation of ADS data and safety testing by insurers will help to develop the requisite public, insurer, and governmental trust to support further ADS deployment.

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[10] A 2019 Reuters/Ipsos poll, half of U.S. adults think automated vehicles are more dangerous than traditional vehicles operated by people, and more than 60 percent of respondents would not pay more to have a self-driving feature on their vehicle. Americans still don't trust self-driving cars, Reuters/Ipsos poll finds, at https://www.reuters.com/article/us-autos-selfdriving-poll/americans-still-dont-trust-self-driving-cars-reuters-ipsos-poll-finds-idUSKCN1RD2QS AAA reports that more than 70 percent of Americans are afraid to ride in a self-driving car, an increase from 63 percent in 2017. Three in Four Americans Remain Afraid of Fully Self-Driving Vehicles, at https://newsroom.aaa.com/2019/03/americans-fear-self-driving-cars-survey/

A prerequisite of that trust, particularly for insurers, is the access to more and better data on the proposed and adopted design and operation of ADS. Through their highly regulated development of rates and coverage, insurers apply many of the objective and independent validations sought for ADS operational safety. Just as with the established and active advocacy of seat belts and air bags, auto insurance companies can work with auto manufacturers and safety advocates to develop and implement commercial standards that can save lives.

NAMIC ISSUE ANALYSIS

NAMIC ADVOCACY

RESPONSIBILITY ASSESSMENT STANDARDS FOR CONDITIONAL AUTOMATION/DUAL CONTROL VEHICLES

Tom Karol
General Counsel – Federal
National Association Of Mutual Insurance Companies

NAMIC®
ISSUE ANALYSIS

TOM KAROL

Tom Karol serves as General Counsel – Federal in NAMIC's Washington, D.C., office. Tom represents NAMIC on issues impacting property/casualty insurance companies and has primary management of NAMIC's response to federal legislation and regulation. Tom has extensive legal, regulatory, and operations experience with major financial services companies, law firms, regulatory agencies, and Congress, having served as legal counsel in federal agencies and with the U.S. Senate Committee on Governmental Affairs.

Acknowledged as a leader in the insurance industry on autonomous vehicles, Tom is on the Board of Directors of both the Highway Loss Data Institute and Advocates for Highway Safety and Auto Safety, and is an Observer on the Uniform Law Commission Committee on Highly Automated Vehicles. Tom has worked directly with National Highway Transportation Safety Administration officials and has provided testimony to Congressional committees on automated driving systems. Tom leads NAMIC's Autonomous Vehicles Council and has been a featured speaker at insurance, actuary and legal conferences. He served on NHTSA panels relating to state jurisdiction and pre-market approval, has worked with the Insurance Institute for Highway Safety supporting the Virginia Tech Transportation Institute as part of the National Cooperative Highway Research Program, and is a stakeholder in the NHTSA Federal Motor Vehicle Safety Standards Considerations for Automated Driving Systems peer review.

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NAMIC membership includes more than 1,400 member companies. The association supports regional and local mutual insurance companies on main streets across America and many of the country's largest national insurers. NAMIC member companies write $268 billion in annual premiums. Our members account for 59 percent of homeowners, 46 percent of automobile, and 29 percent of the business insurance markets.

TABLE OF CONTENTS

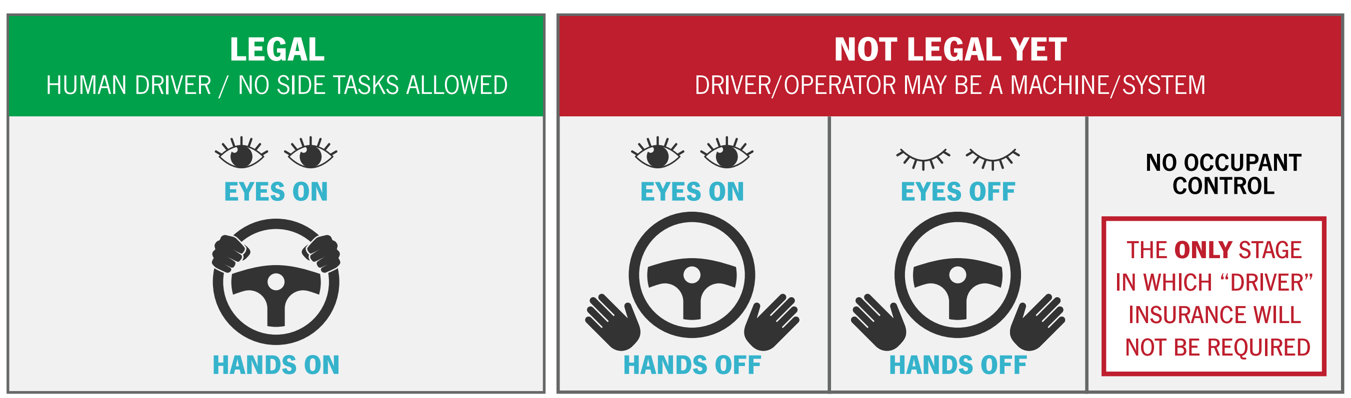
KEY TAKEAWAYS

- While completely autonomous vehicles remain decades away, cars are being developed and sold today in which the driver and the systems in the car share driving tasks.
- These conditional automation/dual control, or CADC, vehicles are complex and vary model to model, with continuous upgrades and modification being made in real time over the air.
- There is a serious lack of understanding of these CADC vehicles, which directly impedes consumer confidence, effective regulation, and the development of these vehicles.
- NAMIC proposes the need for standards that define what the CADC vehicles can and cannot do before they are operated on the public roads, which could greatly increase consumer confidence, provide more protection to developers, help guide regulators, and enable law enforcement and insurers to understand and mitigate crashes.

THE STATE OF AUTOMATED DRIVING SYSTEMS TODAY

There are tremendous efforts underway to develop and deploy automated driving systems. An ADS is a complex computer and mechanical system that gathers information from the environment; filters and interprets that information; chooses driving operations; and initiates mechanical actions to perform those driving operations.

Many ADS developers are actively engaged today in developing vehicles in which some of the dynamic driving tasks of the vehicle – the real-time operational and tactical functions required to operate a vehicle – can only be controlled by the ADS of the vehicle. The Society of Automotive Engineers has created categories of automated driving levels that is widely accepted today.



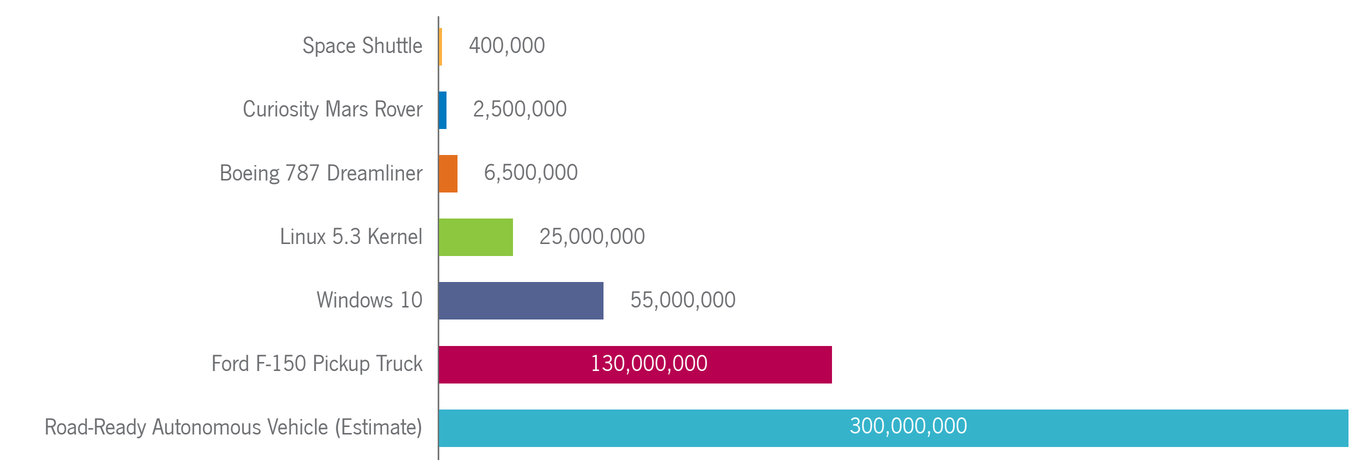
Today, and possibly for a long time to come, the full driving task – SAE Levels 4 and 5 – is too complex an activity to be fully formalized as a sensing-acting robotics system that can be explicitly solved through model-based and learning-based approaches in order to achieve full unconstrained vehicle autonomy.[1]

[1] MIT Advanced Vehicle Technology Study: Large-Scale Naturalistic Driving Study of Driver Behavior and Interaction with Automation, available at https://arxiv.org/pdf/1711.06976.pdf.

- "Ford had overestimated the arrival of autonomous vehicles. At best, we can expect a driverless vehicle that operates within a small, geographically restricted area of a city, like a bus crawling back and forth in a restricted lane at an airport. Anything more is out of the question." Jim Hackett, Ford CEO
- The technology won't be ubiquitous for decades and driverless vehicles will always have constraints. Self-driving cars will require driver assistance for many years to come. Can't envision a day when the technology operates in all weather conditions and without some sort of "user interaction." John Krafcik, Waymo CEO
- "Level 5 will never happen globally. This will only be the case in very few cities." Thomas Sedran, VW CEO
- "The driver can't come out of cars for many years, if not more than a decade." Adam Jonas, Morgan Stanley

A primary impediment to the development and deployment of autonomous vehicles is their mind-boggling complexity and risk, starting with an extremely large amount of computer coding necessary for these vehicles. "[L]et's next look at the average number of defects per 1,000 lines of code, for which there is ample data in various analyst reports: we see up to 50 defects, thereof about ten critical defects, per 1,000 lines of code. Even if only 1% of these were to impact cyber security, our AV would hit the road with an estimated 30,000 cyber defects hidden in its software guts."[2]

LINES OF CODE



Source: NASA, Forbes, Linux, Microsoft, Frost & Sullivan, and BCG Analysis

However, car companies – or original equipment manufacturers, as they are known – are building and offering cars today in which the dynamic driving tasks of the vehicle can be controlled at times by the vehicle and at times by the occupant. These conditional automation/dual-control cars can be as relatively simple as the widely used automatic braking, variations of which include:[3]

[2] Stefan A. Deutscher in "Cyber resilience will make or break the dream of autonomous vehicles at scale," Automotive World, October 7, 2019, at https://www.automotiveworld.com/articles/cyber-resilience-will-make-or-break-the-dream-of-autonomous-vehicles-at-scale/.
[3] Guide to Automatic Emergency Braking, Consumer Reports, August 5, 2019, at https://www.consumerreports.org/car-safety/automatic-emergency-braking-guide/

- Forward Automatic Emergency Braking: Brakes are automatically applied to prevent a collision or reduce impact force while the car is traveling forward.
- Rear Automatic Emergency Braking: Brakes are automatically applied to prevent a collision or reduce impact force while the car is traveling in reverse.
- Automatic Emergency Braking with Pedestrian Detection: Brakes are automatically applied to prevent a collision or reduce impact force with pedestrians or bicyclists while the car is traveling forward.
- City Speed Automatic Emergency Braking: Brakes are automatically applied to prevent a collision or reduce impact force at city speeds, typically 50 mph and below.
- Highway Speed Automatic Emergency Braking: Brakes are automatically applied to prevent a collision or reduce impact force at highway speeds, above 50 mph.

These OEMs are building and selling cars that perform more and more dynamic driving tasks. Perhaps the best known is the Tesla Autopilot that "enables your car to steer, accelerate and brake automatically within its lane."[4] Cadillac Super Cruise claims to offer "hands-free driving on compatible highways," "maintain a selected following gap between you and the detected vehicle ahead," and "help keep you traveling in your lane."[5] Audi reportedly will be the first automaker to offer a car that can safely control itself, but still needs a human available to take over if, say, the weather turns inclement or the lane lines disappear.[6]

In November 2019 testimony before the United States Senate Committee on Commerce, Science, and Transportation, Robert Sumwalt, board chairman of the National Transportation Safety Board, noted that one of the main sources of confusion in discussions about AVs is the language used in the auto industry and by researchers and regulators compared to what is used by the general public. Industry, regulators, and academics frequently use the six-level SAE automation taxonomy as a reference point when discussing vehicle capabilities and operator responsibilities, but Sumwalt maintained that the SAE automation levels may not be easily relatable to the general public, and the terms used by vehicle manufacturers to market their partial-driving automation systems can add to public confusion about the degree of automation in the production-level vehicles now available.[7]

It is important to note that these and other advanced driving assistance features specify that they do not substitute for the driver's responsibility to operate the vehicle in a safe manner; that the driver should remain attentive to traffic, surroundings, and road conditions at all times; and that visibility, weather, and road conditions may affect feature performance. Additionally, some of the driving automated systems offered today have proven to be far less effective than advertised.[8] Although much attention and federal effort have been focused on highly automated SAE Level 3–5 vehicles, NTSB's Sumwalt advised that of equal and more immediate concern should be the current deployment of partial-driving automation systems on our nation's highways.[9]

[4] Future of Driving. Tesla, at https://www.tesla.com/autopilot

[5] https://www.cadillac.com/world-of-cadillac/innovation/super-cruise

[6] Americans Can't Have Audi's Super Capable Self-Driving System, Wired, May 15, 2019, at https://www.wired.com/story/audi-self-driving-traffic-jam-pilot-a8-2019-availablility/

[7] Testimony of The Honorable Robert L. Sumwalt, III, chairman, National Transportation Safety Board, before the Committee on Commerce, Science, and Transportation, United States Senate hearing "Highly Automated Vehicles: Federal Perspectives on the Deployment of Safety Technology," pages 1-2 at https://www.commerce.senate.gov/services/files/B8EF39B5-DE24-48AA-A870-B6CF8E0D5033.

[8] Automatic emergency braking systems with pedestrian detection technology in some late model vehicles perform inconsistently and proved to be completely ineffective at night, new 2019 research from AAA reveals. https://midatlantic.aaa.com/public-affairs/press-release/?Id=84ff9a4f-e645-41eb-92a9-cbf479ba1eb6

[9] Sumwalt testimony, page 5.

While CADC vehicles are certainly a logical step in technological development, different OEMs will offer various features with diverse functionality operated under assorted conditions and limitations. This wide-ranging variety of CADC vehicles results in significant safety and liability risks.

In a CADC vehicle, a human occupant will be required under varying conditions to assume control under expected conditions, such as leaving a highway to small side roads, as well as under emergency conditions. One of the major perceived benefits of automated vehicles is enabling occupants to be partially disengaged from the driving operations, allowing them to rest, relax, or perform other functions. They are only partially disengaged because control of the vehicles can and will be handed over to them in defined[10] and emergency situations. Prior to and during these driving function handover situations, the human driver is expected to watch and understand all the vehicle's actions, but also be available and prepared to resume vehicle-specific manual control in both defined conditions as well as situations that the vehicle cannot handle. Although testing of more autonomous prototype vehicles has taken place in several cities, these vehicles have had safety drivers behind the wheels to monitor the vehicles and be ready to take over at the first sign of trouble.

This will require that the human driver, perhaps engaged in non-driving activities, remain vigilant to driving conditions. It would be unreasonable to expect people disengaged from the driving task to resume control of the vehicle immediately, but it is equally impracticable to create a handover system that takes an undue length of time once the vehicle indicates the intention of handing back control to the driver. This handover period will vary from function to function and from vehicle to vehicle.

THE PROBLEM – NOT KNOWING WHAT CADCS DO/DON'T DO

Proponents of automated vehicle technology often cite the 2015 NHTSA Critical Reasons for Crashes Investigated in the National Motor Vehicle Crash Causation Survey[11] that found driver operations to be the critical reason for 94 percent of the crashes reviewed. Those driver operations were broadly classified into recognition errors, decision errors, performance errors, and non-performance errors. Recognition error, at 41 percent, was the most frequently assigned critical reason. Decision error accounted for about 33 percent of the crashes, and in about 11 percent of the crashes, the critical reason was performance error with other driver errors recorded as critical reasons for about 8 percent.

However, there are two certainties in which we can be confident. First, CADC vehicles will be involved in crashes; no system is 100 percent safe, and these vehicles have special risks. Second, there will be many questions after crashes of CADC vehicles as to whether the system or the driver was in control of the vehicle leading up to the crash.

The lack of understanding of CADC capabilities and limitations increases safety risks. It might not be immediately apparent who controls the vehicle or whether vehicle control and supervision are shared between the computer (the vehicle) and the human operator.[12] Mismatches among a designer's intent for how systems should be used, what the interfaces should communicate to drivers about those systems, and how drivers should use that information when operating the vehicle result in driver misuse and overreliance on the CADC.[13] When the operator does not understand the capabilities and limitations

[10] For example, leaving a highway and entering a back road in an SAE Level 4 vehicle.

[11] https://crashstats.nhtsa.dot.gov/Api/Public/ViewPublication/812115

[12] Sumwalt testimony, page 4.

[13] Effects of training and display content on Level 2 driving automation interface usability, Insurance Institute for Highway Safety, June 2019 https://www.iihs.org/api/datastoredocument/bibliography/2191.

of a CADC, the operator may not even know when he/she should exercise control. "Poor system limitation comprehension appears to hinder the ability to detect system inactivity when the system encounters situations that it cannot handle, which emphasizes the need for more intuitive interface communication strategies about system functionality and when drivers need to intervene."[14]

DEFINING WHAT CADCS DO/DON'T DO

In order to fully understand a crash involving a CADC vehicle, it is important to understand the designed capabilities and limitations of the CADC vehicle and how and when driving operations were engaged or disengaged leading up to the crash. Combining what the CADC vehicle was designed to do with what the CADC vehicle actually did leading up to the crash will determine whether the human operator or the vehicle's operating system was responsible for the crash.

According to Sumwalt, "As more manufacturers deploy driving automation systems on their vehicles, to improve system safety, it will be necessary to develop detailed information about how the active safety systems performed during, and how drivers responded to, a crash sequence. Manufacturers, regulators, and crash investigators all need specific data in the event of a system malfunction or crash."[15]

It is crucial for the insurance industry to consult with OEMs, tech companies, ride-sharing companies, law enforcement groups, legislators, and regulators to develop a broad outline set of questions that help define the answers needed. The following queries developed by NAMIC provide the backbone for a framework to provide such answers and are illustrated in Appendix I to this paper.

- Can a CADC vehicle control any driving operations (steering, braking, acceleration)?
- Were the vehicle driving operation controls engaged?
- Did the vehicle allow/require occupant control?
- Was the occupant required or notified to take control?
- Was the occupant made aware of all operational domains and constraints?
- Was it reasonable for the occupant to take control?
- Did the control that the operator assumed – or should have assumed – (steering, braking, acceleration) cause or contribute to the crash?

Each of these questions can be addressed in more detail by a series of data points requested and can be used to develop Responsibility Assessment Standards for CADC Vehicles. The purpose of a set of Responsibility Assessment Standards for CADC Vehicles is to enable drivers, OEMs, insurers, and law enforcement to better understand whether the ADS of the vehicle or the occupant was responsible for the crash.

[14] Ibid.
[15] Sumwalt testimony, page 9.

Defining the operational design functions of the vehicle will provide a flexible system that will allow for CADC developments that may be unforeseen. Understanding the operational design of the CADC will be most important since the CADC will evolve in ways that are almost impossible to predict today. Consider the Tesla Smart Summon feature. The California Department of Motor Vehicles has reportedly determined that the combination of Smart Summon and the car's robot system doesn't count as "autonomous technology" that requires a permit and safety features because the car is "under the control" of the person summoning his/her car via a smartphone. As developments in autonomous and CADC vehicles get more complex and novel, the underlying key will be to define how operational control of driving tasks are designed to be allocated, shared, excluded, and required.

Insurance Institute for Highway Safety research in 2019 indicates that consumers will likely look for information on the use of automated and assisted driving systems. While the owner's manual was cited as the primary source of information on how to use the automated driving systems by more than half of respondents to an IIHS survey, these results show that respondents would consult a variety of sources, including the OEM website (60 percent) and consumer information websites (38 percent).[16] Another 2019 study by researchers from the IIHS and the Massachusetts Institute of Technology's AgeLab found that, for the most part, drivers use the technology as it was intended.[17]

It is important to note that data points sought from OEMs in Responsibility Assessment Standards should be crafted with a keen consideration of the proprietary information that OEMs have and need to protect. The data sought should not probe into the mechanics or details of how functionality is achieved, but rather what the OEM has designed and built the CADC to perform and the limitations of that performance. The questions asked in this paper are designed to avoid approaching proprietary information or confidential business information.

One the biggest impediments to the deployment of CADC vehicles is public wariness of automated vehicles. Based on recent studies, public confidence in "self-driving" cars is low.[18] Providing more specific information about what each model of CADC vehicle is designed to do will enable consumers to better understand and accept their responsibilities in these vehicles.

Increasing confidence in CADC technology through access to more and better information of specific capabilities and limitations of a vehicle could enhance the safe operation of these vehicles and prepare consumers for higher levels of automation in the future. By providing clear guidance to operators of CADC vehicles and ensuring the understanding and acceptance by operators, an OEM can also better manage its risk and liabilities for crashes.

The lack of this same information has been an impediment to the further development and implementation for clear federal and state regulations for the deployment of CADC vehicles. By making this information widely available without government regulations, OEMs can provide regulators with the assurances they need but retain the flexibility to modify disclosures to address upgrades and revisions. False or misleading information will remain subject to existing civil and criminal sanctions.

[16] What's in a name? Drivers' perceptions of the use of five SAE Level 2 driving automation systems, Insurance Institute for Highway Safety, June 2019. https://www.iihs.org/api/datastoredocument/bibliography/2190
[17] Is automation used where it's intended? Insurance Institute for Highway Safety, https://www.iihs.org/news/detail/is-automation-used-where-its-intended.
[18] A 2019 Reuters/Ipsos poll found half of U.S. adults think automated vehicles are more dangerous than traditional vehicles operated by people, and more than 60 percent of respondents would not pay more to have a self-driving feature on their vehicle. Americans still don't trust self-driving cars, Reuters/Ipsos poll finds, at https://www.reuters.com/article/us-autos-selfdriving-poll/americans-still-dont-trust-self-driving-cars-reuters-ipsos-poll-finds-idUSKCN1RD2QS. A 2018 poll by J.D. Power and NAMIC found that 42 percent said they would never ride in a fully automated vehicle. AAA reports that more than 70 percent of Americans are afraid to ride in a self-driving car, an increase from 63 percent in 2017. Three in Four Americans Remain Afraid of Fully Self-Driving Vehicles, at https://newsroom.aaa.com/2019/03/americans-fear-self-driving-cars-survey/.

Along those same lines, having detailed and current information on specific CADC vehicle capabilities and limitations would be of benefit to law enforcement and traffic officials who will need to understand when human drivers are required to be focused on driving operations, as well as when investigating crashes involving CADC vehicles.

Operators of CADC vehicles will need insurance, and this information will enable insurers to better gauge relative risk levels of different CADC vehicles and determine coverage responsibility in crashes of CADC vehicles. Insurance for these vehicles today is limited and costly; as evidenced by Tesla's need to create its own insurance company.[19]

NEXT STEPS

NAMIC has worked with various stakeholders to develop proposed Responsibility Assessment Standards for conditional automation or dual control vehicles for wider consideration and refinement that will serve as a platform for further development and adoption, as seen in Appendix I. The acceptance of a platform by all industries will promote the development and deployment of safer vehicles and ensure mutual accountability. Most likely, the standards will continue to evolve with the development of CADCs and more autonomous vehicles.

When standards are sufficiently refined to meet the needs of the public and relevant stakeholders, the next significant step would be the development of specific logistics in collecting, updating, and widely communicating the information relating to these standards. In general, NAMIC believes that the most workable system would be a voluntary platform in which OEMs use the standards to make information publicly available. This will afford the flexibility that will be needed as CADCs and more autonomous vehicles continue to develop. This will also allow OEMs to use the standards to explain their vehicles, rather than having to comport their vehicles to a rigid regulatory category.

Overall, the goal is to provide consumers access to information that would help them operate safer CADC vehicles. Greater disclosure of CADC capabilities and limitations can help OEMs protect themselves from liability for the improper or misuse of their products. This information will also allow legislators and regulators to better understand CADC and autonomous capabilities and limitations in considering relevant laws and regulations. A flexible and evolving system of information may even elevate the need for less flexible federal and state requirements. Armed with detailed information on a specific vehicle's capabilities and limitations, traffic officers will be able to quickly appreciate when driver behavior is permitted and prohibited. When the inevitable crashes occur, law enforcement and insurers can better assess and address responsibility. Insurance companies can use this current information to provide more and better coverage for CADC vehicles, as well as understand and help mitigate risks from the inevitable crashes.

Entities that choose not to participate would subject themselves to a competitive market disadvantage. Entities that provide inadequate or bad information will be subject to prompt and wide public review, as well as existing civil and criminal liability. A central clearinghouse for the collection, maintenance, and distribution of the information may make sense overall and could provide a level of quality control.

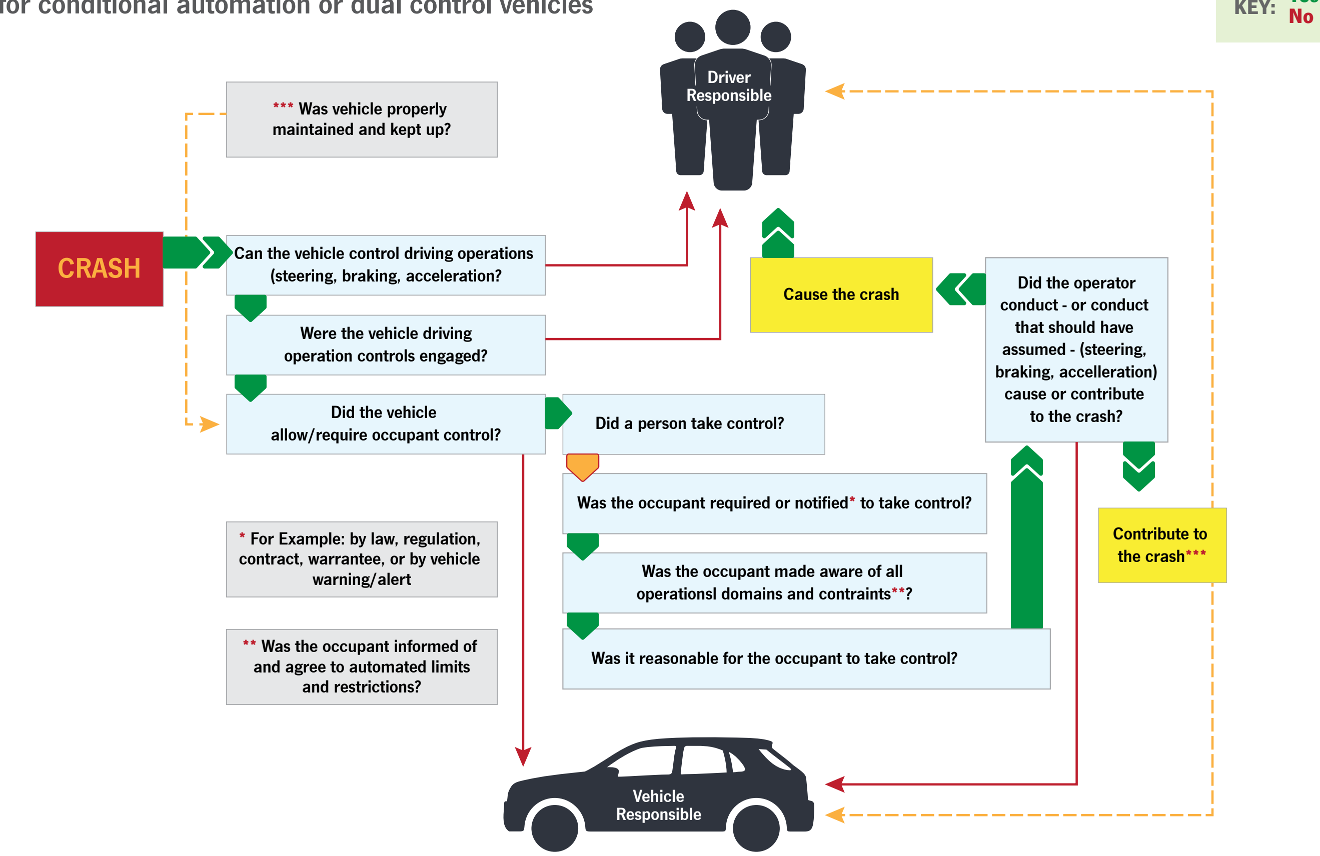
Like CADCs and autonomous vehicles, standards will evolve. With the cooperation of numerous stakeholders, standards such as those proposed in Appendix I can develop for wider consideration to promote the development and deployment of safer vehicles.

[19] How Tesla plans to cut customers' insurance costs: Tap into Autopilot, Automotive News, May 13, 2019, at https://www.autonews.com/finance-insurance/how-tesla-plans-cut-customers-insurance-costs-tap-autopilot.

APPENDIX I

RESPONSIBILITY ASSESSMENT STANDARDS FOR CONDITIONAL AUTOMATION OR DUAL CONTROL VEHICLES

Post-crash ads responsibility assessment standards for conditional automation or dual control vehicles



A. CAN THE VEHICLE CONTROL DRIVING OPERATIONS (STEERING, BRAKING, ACCELERATION)?

1) What driving operations is the Automated Driving System ("ADS") of the vehicle designed to control?

a) Steering

b) Braking

c) Acceleration

d) Other________________________________

2) Which dynamic driving tasks – the real-time operational and tactical functions required to operate a vehicle in traffic – is the vehicle's ADS designed to control?

a) Lateral vehicle motion control via steering (operational)

b) Longitudinal vehicle motion control via acceleration and deceleration (operational)

c) Monitoring the driving environment via object and event detection, recognition, classification, and response preparation (operational and tactical)

d) Object and event response execution (operational and tactical)

e) Maneuver planning (tactical)

f) Enhancing conspicuity via lighting, signaling, gesturing, etc. (tactical)

g) Other ____

3) What are the operational design domains of the vehicle – i.e. the specific conditions under which the ADS of vehicle is designed to control driving operations?

a) Environmental

b) Geographical

c) Time-of-day restrictions

d) Requisite presence of traffic or roadway characteristics

e) Requisite absence of traffic or roadway characteristics

f) Other ____

4) What are the operational design limitations and constraints – the conditions under which the ADS of vehicle is not designed to control driving operations?

a) Environmental

b) Geographical

c) Time-of-day restrictions

d) Requisite presence of traffic or roadway characteristics

e) Requisite absence of traffic or roadway characteristics

f) Other____

5) What data on the functions above are recorded, retained, and/or reported?

6) Where is the recorded, retained, and/or reported data accessible?

7) How is the recorded, retained, and/or reported data accessible?

8) For what period is the recorded, retained, and/or reported data accessible?

9) Who is authorized to access the recorded, retained, and/or reported data?

B. HOW ARE THE VEHICLE'S ADS DRIVING OPERATION CONTROLS DESIGNED TO BE ENGAGED?

1) What driving operations are the vehicle's ADS designed to control?

a) Steering

b) Braking

c) Acceleration

d) Other________________________________

2) Are the ADS of the vehicle driving operations controls designed to be engaged automatically or by the occupant?

	Automatic Engagement	Automatic Disengagement	Human Engagement	Human Disengagement
Steering				
Braking				
Acceleration				
Other				

3) What actions are required in the vehicle design for the ADS driving operations controls designed to be engaged or disengaged?

	Automatic Engagement	Automatic Disengagement	Human Engagement	Human Disengagement
Steering				
Braking				

4) What preconditions, if any, is the ADS designed to require for the vehicle driving operations for controls to be engaged or disengaged?

	Automatic Engagement	Automatic Disengagement	Human Engagement	Human Disengagement
Steering				
Braking				

5) Is the system designed to notify occupants notified of the driving operations controls that are engaged and not engaged by the ADS of the vehicle?

a) No

b) Yes – How?

6) Is the system designed to notify occupants notified of the Operational Design Domains and limitations of the ADS of the vehicle?
   a) No
   b) Yes – How?

7) Is the system designed to notify occupants of the vehicle operation outside the Operational Design Domains?
   a) No
   b) Yes – How?

8) What data on the functions above are recorded, retained, and/or reported?

9) Where is the recorded, retained and/or reported data accessible?

10) How is the recorded, retained, and/or reported data accessible?

11) For what period is the recorded, retained, and/or reported data accessible?

12) Who is authorized to access the recorded, retained, and/or reported data?

C. HOW IS THE VEHICLE DESIGNED TO ALLOW OR REQUIRE OCCUPANT CONTROL?

1) What driving operations is the vehicle's ADS designed to control?
   a) Steering
   b) Braking
   c) Acceleration
   d) Other________________________________

2) When the vehicle ADS is controlling any driving operation, is the ADS designed to allow occupants to mutually control that same driving operations?

ADS Control Is Engaged	Steering	Braking	Acceleration	Other
Occupant Can Steer				
Occupant Can Brake				
Occupant Can Accelerate				

3) Which dynamic driving tasks of ADS driving operations controls are designed to be **voluntarily** disengaged by occupants?
   a) Steering
   b) Braking
   c) Acceleration
   d) Other________________________________

4) Which dynamic driving tasks of ADS driving operations controls are designed to be disengaged by the ADS and **required** to be reengaged by occupants?
   a) Steering
      i) Conditions:
   b) Braking
      i) Conditions:
   c) Acceleration
      i) Conditions:
   d) Other________________________________
      i) Conditions:

5) SAEJ3016 8.3 provides that level 4 or 5 vehicles may have "an emergency stop lever." Does this vehicle have this feature or its equivalent?
   a) If so, under what conditions is the vehicle designed to allow the feature to be engaged?
   b) How is the vehicle designed for the occupant to be required, allowed, limited, or prohibited to engage the feature?

6) What data on the functions above are recorded, retained, and/or reported?

7) Where is the recorded, retained, and/or reported data accessible?

8) How is the recorded, retained, and/or reported data accessible?

9) For what period is the recorded, retained, and/or reported data accessible?

10) Who is authorized to access the recorded, retained, and/or reported data?

D. HOW IS VEHICLE DESIGNED TO ALLOW OR REQUIRE AN OCCUPANT TO TAKE CONTROL OF DRIVING OPERATIONS?

ALLOW

1) Is the vehicle designed to allow an occupant to voluntarily disengage **all** ADS driving control and assume manual control of driving operations?
   a) How is the vehicle designed to allow an occupant to voluntarily disengage **all** ADS driving control and assume manual control of driving operations?

2) Is the vehicle designed to allow an occupant to voluntarily disengage **some but not all** ADS driving control and assume manual control of driving operations?
   a) How is the vehicle designed to allow an occupant to voluntarily disengage **some but not all** ADS driving control and assume manual control of driving operations?

RESTRICT

3) Is the vehicle designed to restrict an occupant from voluntarily disengaging **all** ADS driving control and assuming manual control of driving operations?
   a) How is the vehicle designed to restrict an occupant from voluntarily disengaging **all** ADS driving control and assuming manual control of driving operations?

4) Is the vehicle designed to restrict an occupant from voluntarily disengaging **some but not all** ADS driving control and assuming manual control of driving operations?
   a) How is the vehicle designed to restrict an occupant from voluntarily disengaging **some but not all** ADS driving control and assuming manual control of driving operations?

PROHIBIT

5) Is the vehicle designed to prohibit an occupant from voluntarily disengaging **all** ADS driving control and assuming manual control of driving operations?
   a) How is the vehicle designed to prohibit an occupant from voluntarily disengaging **all** ADS driving control and assuming manual control of driving operations?

6) Is the vehicle designed to prohibit an occupant from voluntarily disengaging **some but not all** ADS driving control and assuming manual control of driving operations?
   a) How is the vehicle designed to prohibit an occupant from voluntarily disengaging **some but not all** ADS driving control and assuming manual control of driving operations?

7) Is the vehicle designed so that all vehicle driving operation controls taken back by the occupant are in compliance with the relevant FMVSS requirements?

8) Is the vehicle designed for an occupant who has taken control of driving operations to give vehicle driving operations control back to the ADS?
   a) How is the vehicle designed so that an occupant who has taken control of driving operations can give vehicle driving operations control back to the ADS?
   b) Is the vehicle designed to inform the occupant as to which controls of driving operations the ADS have and have not resumed?

9) Is the vehicle designed to enable the ADS to take vehicle driving operations control from an occupant without the occupants' consent?
   a) How is the vehicle designed to enable the ADS to take vehicle driving operations control from an occupant without the occupants' consent?

10) What data on the functions above are recorded, retained, and/or reported?

11) Where is the recorded, retained and/or reported data accessible?

12) How is the recorded, retained, and/or reported data accessible?

13) For what period is the recorded, retained, and/or reported data accessible?

14) Who is authorized to access the recorded, retained, and/or reported data?

E. WAS THE OCCUPANT REQUIRED OR NOTIFIED TO TAKE CONTROL OF ANY DRIVING OPERATIONS?

1) Is the vehicle designed to disengage **all** ADS driving control and require an occupant to assume manual control of driving operations?
   a) How is the vehicle designed to disengage **all** ADS driving control and require an occupant to assume manual control of driving operations?

2) Is the vehicle designed to disengage **some but not all** ADS driving control and require an occupant to assume manual control of driving operations?
   a) How is the vehicle designed to disengage **some but not all** ADS driving control and require an occupant to assume manual control of driving operations?

3) Is the vehicle designed to inform the occupant of the driving operations for which the occupant has taken or been required to take control?
   a) How is the vehicle designed to inform the occupant of the driving operations for which the occupant has taken or been required to take control?

4) Is the vehicle designed to verify that the occupant required to assume manual control of driving operations has any specific knowledge, ability, and/or acceptance of that driving operation control responsibility?

a) How is the vehicle designed to verify that the occupant required to assume manual control of driving operations has any specific knowledge, ability, and/or acceptance of that driving operation control responsibility?

5) If there are multiple occupants in the vehicle, is the vehicle designed to verify that any or all of the occupants have the knowledge, ability, and acceptance of driving operation control responsibility?

a) How is the vehicle designed to verify that any or all of the occupants have the knowledge, ability, and acceptance of driving operation control responsibility?

b) Is the vehicle designed to continue to operate under the ADS without verified knowledge, ability, and acceptance of any occupant driving operation control responsibility?

6) Is the vehicle designed to provide any information or instructions to occupants of driving operation control for which an occupant may be responsible?

a) How are these instructions provided?

b) How do occupants verify knowledge and/or ability for acceptance of driving operation control responsibility?

c) How do occupants accept driving operation control responsibility?

7) What data on the functions above are recorded, retained, and/or reported?

8) Where is the recorded, retained, and/or reported data accessible?

9) How is the recorded, retained, and/or reported data accessible?

10) For what period is the recorded, retained, and/or reported data accessible?

11) Who is authorized to access the recorded, retained, and/or reported data?

F. WAS THE OCCUPANT MADE AWARE OF ALL OPERATIONAL DOMAINS AND CONSTRAINTS?

1) Is the vehicle designed to inform occupants of any and all occupant responsibilities?

a) How is the vehicle designed to inform occupants of any and all occupant responsibilities?

2) Is the vehicle designed to inform occupants as to what the ADS can do and what the ADS will not do, and under what conditions and limitations?

a) How is the vehicle designed to informed occupants of the ADS operational domains and constraints?

3) Is the vehicle designed to inform occupants of any notifications or warnings that the occupants may be given during driving operations and what the notifications mean?

a) How is the vehicle designed to inform occupants of any notifications or warnings that the occupants may be given during driving operations and what the notifications mean?

4) Is the vehicle designed to require occupants to verify that they understand and accept the ADS the information in 1), 2), and 3) prior to use of the vehicle?

a) How is the vehicle designed to require occupants to verify that they understand and accept the ADS the information in 1), 2), and 3) prior to use of the vehicle?

5) What data on the functions above are recorded, retained, and/or reported?

6) Where is the recorded, retained, and/or reported data accessible?

7) How is the recorded, retained, and/or reported data accessible?

8) For what period is the recorded, retained, and/or reported data accessible?

9) Who is authorized to access the recorded, retained, and/or reported data?

G. HOW AND WHEN CAN THE OCCUPANT TAKE CONTROL?

1) Voluntary Occupant Assumption of Control

a) Which controls of driving operations is the vehicle designed to allow the occupant to voluntarily engage or disengage from the ADS during driving operations?

b) Which controls of driving operations is the vehicle designed to **not** allow the occupant to voluntarily engage or disengage from the ADS during driving operations?

c) What preconditions, if any, is the vehicle designed to require for driving operations controls to be voluntarily engaged or disengaged by an occupant?

d) Are there conditions in which the vehicle is designed to not allow the occupant to voluntarily assume control of driving operations?

e) What actions is the vehicle designed to require from an occupant for driving operation controls to be engaged or disengaged by an occupant?

f) How much time is required by the vehicle to allow the occupant to voluntarily assume control of driving operations?

2) Vehicle Requires Occupant Assumption of Control

   a) Under what conditions is the vehicle designed to **require** an occupant to assume any control of driving operation controls?

   b) If the ADS require an occupant to assume control, how is the vehicle designed to notify an occupant of which driving operations controls to take over?

   c) How much time, after the occupant is alerted by the ADS for the occupant to assume control, is the vehicle designed to require the occupant to assume control of driving operations?

   d) How is the vehicle designed to determine/verify whether the occupant has assumed control of the driving operation?

   e) What is the vehicle designed to do if the occupant does not assume control of the driving operation?

3) What data on the functions above are recorded, retained, and/or reported?

4) Where is the recorded, retained, and/or reported data accessible?

5) How is the recorded, retained, and/or reported data accessible?

6) For what period is the recorded, retained, and/or reported data accessible?

7) Who is authorized to access the recorded, retained, and/or reported data?

H. DID THE CONTROL THAT THE OPERATOR ASSUMED – OR SHOULD HAVE ASSUMED – (STEERING, BRAKING, ACCELERATION) CAUSE OR CONTRIBUTE TO THE CRASH?

Immediately prior to the crash and at the time of the crash, insurers and law enforcement will want to know the following:

1) Which driving operation controls to be controlled exclusively by the ADS is the vehicle designed to record?

2) Which driving operation controls to be controlled by a human driver exclusively is the vehicle designed to record?

3) Is the vehicle designed to record when the human operator retained all driving operations from the beginning of the operation of the vehicle?

4) Is the vehicle designed to record when the ADS retained all driving operations from the beginning of the operation of the vehicle?

5) Is the vehicle designed to record when a human operator turned any or all driving operation control over to the ADS?

6) Is the vehicle designed to record when the ADS turned any or all driving operation control over to the human driver?

7) Is the vehicle designed to record when the ADS notified an occupant that the ADS was required to turn any or all driving operation control over to the human driver?

8) Is the vehicle designed to record when a human driver took over or attempted to take over driving operation controls from the ADS?

9) Were there controls of driving operations that the human operator was required or recommended to assume that the human operators did not assume?

10) What data on the functions above are recorded, retained, and/or reported?

11) Where is the recorded, retained, and/or reported data accessible?

12) How is the recorded, retained, and/or reported data accessible?

13) For what period is the recorded, retained, and/or reported data accessible?

14) Who is authorized to access the recorded, retained, and/or reported data?

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