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**U.S Senate Committee on Commerce, Science, and Transportation**

**Paving the Way for Self-Driving Vehicles**

**Testimony by**

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**American Center for Mobility**

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On behalf of the American Center for Mobility, it is an honor to provide testimony about the future of automated vehicle (AV) and transportation technology, and key steps for creating a much safer and more efficient transportation system.

This testimony will focus on the need to maximize the benefits of new transportation technologies for the United States, while ensuring safe deployment on public roads. It will explain how voluntary standards inform federal regulation, and how these can be accelerated through coordinated industry and government collaboration, including the USDOT Automated Vehicle Proving Ground (AVPG) Program. It will also describe the need for new tools and data, including practical flexibility in the NHTSA Part 555 exemption program to enable the near-term development and long-term deployment of these safety-beneficial highly automated vehicle (HAV) technologies.

The American Center for Mobility is a non-profit public/private partnership. We are building a world-leading facility for innovation, testing and product development, to act as a national proving ground for future mobility. First and foremost, we are focused on public safety, including the safe testing, validation, and self-certification of connected and automated vehicle and infrastructure mobility technology. In addition to testing, our mission is to accelerate the development of standards, and to provide educational opportunities. ACM incorporates a purpose-built test track environment directly integrated with active on-road highway corridors, simulation laboratories, and a combined corporate/academic technology park campus to facilitate effective industry, government and academic collaboration and information sharing, as well as a focus on educating the mobility workforce for the future, STEM K-12 programs, and educating the public in general.

**It is clear we need a significant change in our transportation system.**

Our past transportation system has served us well over the last 100 years, but is showing signs of strain. Every year we endure a national tragedy of tens of thousands of Americans losing their lives on our roads, in urban, suburban, and rural areas. That is the numerical equivalent of over

ten *September 11 Attacks*, or seven *Iraq Wars*, every year. In many cities, we see ever-increasing congestion, with accompanying loss of productive time, wasted energy, and unnecessary greenhouse gas emissions. Largely we have accepted these undesirable outcomes as the status quo. It is clear we need a significant change, and we are now on the cusp of introducing connected automated vehicle (CAV) technology that can begin that change.

Safety must be everyone's first focus. NHTSA's census of fatal car crashes (1) shows that 35,092 people lost their lives in 2015. Historically, human error or actions account for, or contributed to, 94% of these fatal crashes. (2) By reducing the effects of human error, connected and automated vehicles have the promising potential to reduce or even eliminate these fatal outcomes by avoiding the crash scenario altogether.

**Because of promising safety potential, the United States should focus on developing and deploying CAV technology in the most responsibly expedient manner possible.**

Transportation is the lifeblood of our economy and society. The ability to efficiently and effectively move people and goods is critical to the social and economic well-being of the United States, and will help us remain competitive with other international economies. The United States covers a very large geographic area, and part of our industrial and economic strength is that we can transport people and goods across that large area in a safe, efficient, and economical manner. In addition to safety benefits, CAV technology provides the opportunity for a "systems approach" to transportation, with substantial potential improvements in mobility, energy use, equity in transportation, and positive impact on the nation's economy.

AV technology is being developed very rapidly, largely led by industry, but aided by key frameworks, research, and support from Government and Academia. While we have one hundred years of experience with human-driven vehicles, we need to gather experience and data with automated vehicles in a much shorter timeframe. Inherently, automated vehicles will be data-rich due to the basic operational need to sense, analyze, and act on data that is generated continuously through operation. We need the initial experience of operating these vehicles in sufficiently substantial numbers to generate the broad data across a multitude of scenarios and environmental operating conditions necessary to ensure safety, and to scale the technology to full deployment.

Over the last decades, automotive safety technology has progressed significantly, and that progression has resulted in the savings of hundreds of thousands of American lives. (3) The development and introduction of each technology has required a very thorough engineering process, including research, testing, product development, verification, validation, standardization, certification, education, and in-use monitoring. Even the simplest of technologies, the seat belt, was conceived, designed, and introduced through this phased process. Many safety technologies developed by industry and government through this process have become mandated through regulation by Federal Motor Vehicle Safety Standard (FMVSS).

Modern safety technologies have become more and more complex. Airbags and Supplemental Restraint Systems (SRS), Automatic Braking Systems (ABS), Electronic Stability Control (ESC), Forward Crash Warning (FCW), Lane Departure Warning (LDW), Crash Imminent Braking (CIB), and Vehicle-to-Vehicle Communication (V2V) have required ever-greater developmental efforts, and are subject to factors outside the control of the vehicle alone. However the basic engineering processes listed above have proven capable of developing these systems to an extremely robust level that is befitting of a life-saving technology. AV technology will likely be the most complex automotive safety innovation yet deployed, however the basic process honed over the last decades will serve as a capable and required starting point.

Voluntary standards have proven to be a key step in the development of all of these safety technologies. Industry and Government research and testing generate the basic scientific and technical knowledge for a new technology. This leads to standardization of key definitions, designs, test procedures, validation models and methods, and certification protocols that enable a new technology to be commercialized. Often, these become codified in voluntary industry standards, such as by SAE International and other Standards Development Organizations (SDOs). Occasionally, but often for safety technologies, these voluntary standards form the basis for federal regulations as codified by FMVSS, as shown in Figure 1.


**Figure 1. safety technology standards development process**

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**It is critical to accelerate voluntary standards in order to ensure safe deployment of AVs.**

AV technology is being developed and is advancing at a faster rate than the traditional standards process can fully accommodate. SAE international has begun to promulgate basic standards, such as taxonomy and definitions, which have already served as the basis for the Federal AV Guidance. Additional voluntary standards are needed immediately to ensure that these new approaches in testing, validation, data collection, data-sharing, privacy, cybersecurity, and others areas are developed to ensure safety, while not inhibiting or stalling the technology development. These standards will also likely form the technical basis for future FMVSS requirements for vehicle performance or equipment.

It is critical to accelerate these voluntary standards in order to ensure safe deployment of AVs. From now through 2025, AV development will continue to move very rapidly, and initial voluntary standards must be in place by that timeframe to support the first significant vehicle deployments. Other countries and regions, including China and the European Union, are funding and working diligently on standards efforts to support their deployments and industry partners. The complexity of AV technology will require innovative thinking for testing, simulation, validation, standardization, and certification tools and methodologies to support these standards.

Voluntary standards must also be accelerated for purposes of creating a collaborative, unified common approach, and avoiding a patchwork of standards or regulations that could inhibit or stall the technology development. Even a small number of differing or conflicting standards or regulations would significantly inhibit the development of AV technology. Consumers' interests would not be served if they could not operate their vehicle, or a shared vehicle, across state lines. Differing standards could certainly limit the safety, equity, and economic benefit of automated vehicles, and would put the U.S. in a compromised position compared to other countries and regions around the world.

It is also important to consider that the pursuit of voluntary standards does not preclude the promulgation of State or Federal standards. Indeed it may be prudent to consider the adoption of a Federal FMVSS *framework* standard that establishes key foundational requirements, such as definitions, manufacturer identification and reporting processes, data reporting requirements, exemption processes, consumer notification and privacy, enforcement requirements, etc. However it is too early to promulgate significantly detailed vehicle performance or equipment standards, as the needed technical requirements are not sufficiently developed, and currently there is no agreement within the technical and stakeholder community on the nature or specifics of such requirements. Additionally, the premature promulgation of not-fully-developed safety standards could result in a "false sense of safety," whereby manufacturers or consumers may believe that the technology is more ready or capable than it actually is, simply because it is advertised as meeting safety standards.

State regulations are also ultimately necessary for full scale AV deployment. The traditional State roles dictating operational requirements, such as insurance, registration, training and licensing, driving enforcement, etc., are still required, and appropriate, for AVs. States may also want to proscribe new regulations that require HAV owners or fleet operators to make sure safety-critical vehicle control recalls are completed in a timely manner. However, creating state-by-state standards for vehicle performance or equipment could result in this undesirable patchwork, and should be avoided for reasons described above. Additionally, the creation of state-by-state vehicle performance or equipment requirements may also contribute to the "false sense of safety" discussed above.

**USDOT's Automated Vehicle Proving Ground (AVPG) program provides key infrastructure and framework for safe deployment of CAVs.**

USDOT's Automated Vehicle Proving Ground (AVPG) program provides key infrastructure and framework for the development of CAV products, tools, and standards in a rapid and collaborative fashion. This will be a critical asset to ensure safe deployment, as well as ensuring that the US remains competitive in AV industry and deployment. This AVPG Program was established very recently, and has the mission to serve as a Community of Practice (CoP) to enable USDOT, industry, and other stakeholders to develop, test, and validate AV products, standards, and supporting tools.

This CoP will convene and enable stakeholders from companies, government agencies, academia, facilities, consumer groups, and other organization, to share best practices and innovations for testing operator safety, facility design concepts and details, facility operational best practices and lessons learned, data acquisition and analysis system concepts, and testing and analysis equipment best practices and standards. This intellectual capital will form the basis for voluntary standards and mandatory regulation.

AV testing and validation must occur through three coordinated approaches: Closed-Track testing, On-Road testing, and Simulation, as shown in Figure 2 below.

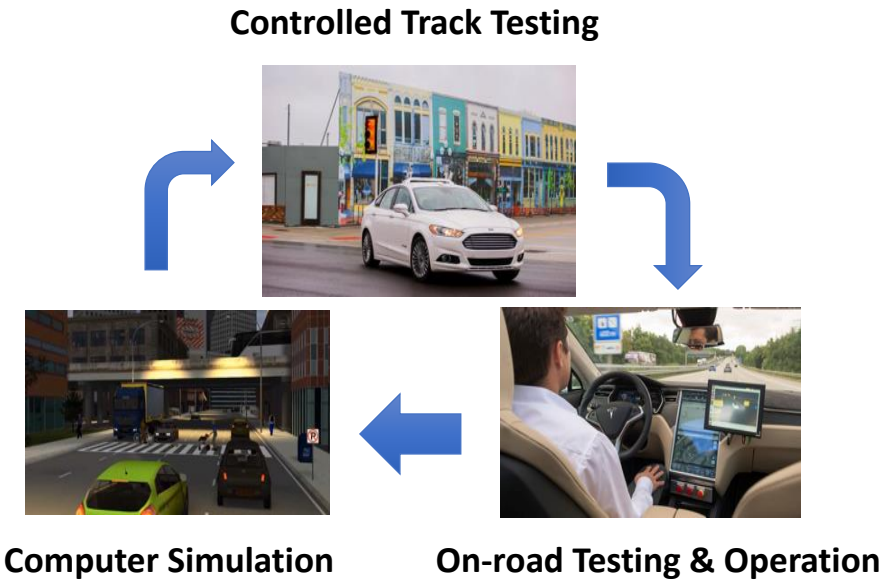


**Figure 2. AV development process – 3 coordinated approaches**

It is crucial that AV testing and development programs include three key complementary and fully integrated tools: 1) **Test-track and laboratory** tests that validate full vehicles, systems, and components, under realistic, variable, repeatable, and controlled conditions; 2) **on-road** tests that verify the systems' robustness in real life situations, including some that can't be implemented, or even imagined, in the above tools; and 3) **detailed simulations**, including roadway, traffic, vehicle, sensors, drivers, infrastructure, etc. that mathematically model the millions of technology and environmental variations.

These testing tools and methodologies must be used in combination in an iterative fashion. Simulation results help prioritize and define the initial round of test-track tests. The test-track allows a safe, controllable, and repeatable environment for development of functionality in numerous scenarios, and provides sufficient confidence to begin on-road testing, but can never accommodate all scenarios. On-road testing provides identification and validation to real-world behavior, including unanticipated, key scenarios, but often does not allow repeatability, so key critical scenarios must be reproduced in simulation and track testing. This process must be rigorously planned and executed to validate artificial intelligence as a substitute for decades of experience of a human driver. These new methodologies are not yet fully defined, and are the subject of intense research and rapid development.

USDOT's AVPG program contains a combination and range of track, on-road, and simulation facilities and capabilities across wide geographic areas and environmental conditions. This range

of capabilities is important for the development of these products and tools in a rapid and collaborative fashion, and will be a critical asset to generate experience and data to ensure the safety of AV products and that the US remains competitive in AV industry and deployment.

AVs present both challenges and opportunities regarding data and data sharing, requiring that a large amount of data and information be sensed, acquired, amalgamated, analyzed for rapid decision-making in a wide variety of travel scenarios and environmental conditions, while protecting consumer privacy and ensuring cybersecurity. This data must then be acted upon through control decisions and operational monitoring. This same data can enable understanding of what is going right, or wrong, with an AV, and if shared, provides an opportunity for many vehicles to learn from the experience of one. While data best practices for AVs are still under significant development by vehicle manufacturers, testers, suppliers, government agencies, and service operators, generally, these data practices will likely include established processes and tools for the collection of in-use event, incident, and vehicle information data for crashes, malfunctions, degradations, failures, and unintended operation outside established operational domains, while maintaining and protecting consumer privacy and manufacturer/tester confidentiality and security. It is expected that this information will become extremely useful for vehicle development and operations activities, especially in early years of deployment, as well as accident/event reconstruction purposes.

The AVPG Program will be critical infrastructure for developing concepts, structures, processes, tools, and programs to enable and implement these data sharing activities that are required for safe deployment, while maintaining consumer privacy and system cybersecurity.

For these reasons, the AVPG Program overall will provide the foundation and program for the development of safe testing, operation, and deployment, including the necessary voluntary standards and mandatory regulations. As described above, significant work will need to be undertaken by expert technical and policy communities to theorize, prioritize, draft, and codify these standards in a coordinated yet accelerated manner. U.S. investment in AVPG infrastructure, facilities, equipment, and programs is a vital necessity to ensure safe deployment of AVs, and to keep the US competitive with other major auto-manufacturing countries who are investing in similar facilities and infrastructure at a much more rapid pace.

**HAV Data collection will continue after initial deployment, and Exemptions are important to allow that data generation.**

HAV data collection and analysis must also extend through the initial years or even decade(s) of deployment. In addition to data gathered and analyzed throughout the product development and validation process, it will be critical to gather data in the initial years of product deployment, and perhaps even continuing ad infinitum. HAVs, like human drivers, must be capable of operating in a wide variety of travel scenarios and environmental conditions. No amount of testing and

simulation can guarantee that every possible scenario has been encountered before initial deployment, just as human driver education cannot accomplish that before a driver is licensed. Secondly, setting of standards, especially government regulation is always aided by the collection and analysis of real-world safety experience and data. Because of this it is imperative to create, collect and analyze in-use data for initial deployments of these HAV vehicles.

According to a 2016 NHTSA/Volpe study, (4) a number of existing FMVSS contain requirements that either conflict with, or do not allow, basic HAV design tenets, especially related to human operated controls. In order to enable that early product deployment and regulatory data gathering, and to enable HAVs in general for their significant safety and mobility potential, it is important that Congress and USDOT review the current authority, and identify and implement a solution for exempting compliance of a sufficiently substantial number of vehicles to FMVSS requirements that do not pertain to HAV design or operation.

CFR 49 Part 555 currently allows NHTSA to temporarily exempt petitioning manufacturers' vehicles from certain FMVSS requirements, based on one or more of four situations:

1) Substantial economic hardship
2) Facilitation of development of new safety features
3) Facilitation of development of new "low-emission" features or vehicles
4) Inability to sell a vehicle with an overall equivalent or greater level of safety

It could be argued that initial deployment of HAVs would already be covered by situations 2, 3, and 4. However the number of vehicles (up to 2,500) and the time duration (up to 2 years) for the exemption is somewhat limited, and may not serve the need of collecting a sufficient body of data to ensure safe operation, and ultimately create appropriate FMVSS requirements.

Notably, and importantly, situations 2, 3, and 4 include the requirement that the petitioner demonstrate an equivalent or better level of safety, as compared to a non-exempted fully conforming vehicle, as part of the information for NHTSA's consideration.

As part of this recommended Congressional and USDOT review, it should be debated whether situation 1 is applicable or advisable as an exemption rationale for HAVs, especially since this basis does not require the demonstration of an equivalent level of safety.

Regardless of the rationale for exemption, it remains imperative for HAVs that the petitioner demonstrate, ideally through test-track, on-road, and simulation data, that the exempted vehicle clearly provides an equivalent or better level of safety, and that NHTSA have the final judgment that that requirement is met. Lastly, NHTSA must be authorized and adequately funded, including appropriate FTE levels, to ensure that this exemption program can be enacted fully and expeditiously so that it meets its full intent.

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Closing

In closing, I wish to reiterate that we are entering a new era for a greatly improved transportation system built on key technologies. The United States must embrace and invest in these technologies to provide increased safety, mobility, and equity for the travelling public, as well as support the economic competitiveness of our automotive industry and our country.

I urge Congress to consider the following:

- Authorize and fund USDOT to direct, fund, and collaborate on voluntary industry standards, including testing, validation, cybersecurity, privacy, and self-certification tools and methodologies, including appropriate FTE to implement this program.
- Authorize and fund the USDOT AVPG program to provide facilities and opportunities for product development, standardization, education, and public-private partnerships.
- Consider revising NHTSA's exemption authority to enable HAV deployment and early data collection, and authorize and fund appropriate FTE to implement this program.

I appreciate this opportunity very much. Thank you for your attention.

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**About The American Center for Mobility**

The American Center for Mobility's proving ground is designated by USDOT as part their AVPG Program. ACM's core mission is to enable the safe development of automated vehicles as part of a future transportation system. To perform that mission, ACM is committed to develop and share safety-related approaches, information, and data in both test facility design and test operations, as well as explore and create data sharing opportunities for non-confidential, non-PI, testing and operation data, as part of a similarly-committed Community of Practice, while maintaining and protecting consumer privacy and manufacturer/tester confidentiality and security.

With $110M in direct or incorporated investment, and leveraging an additional $115M of regional assets, ACM is designed to be the premiere national proving ground for shared-use mobility and advanced automotive testing. Founded in early 2016, ACM is a joint initiative among the State of Michigan, including the Michigan Department of Transportation (MDOT) and Michigan Economic Development Corporation (MEDC), the University of Michigan (U-M), Business Leaders for Michigan (BLM), and Ann Arbor SPARK. ACM incorporates private funding in partnership with public funding from the State of Michigan. ACM is strategically located in southeast Michigan and is recognized as a centerpiece of the state's "Planet M" initiative representing the collective mobility efforts across the state defining Michigan as the global center of mobility.

ACM's testing and validation capability is based on real-world representative testing environments designed to address a wide range of variations of pre-crash scenarios, including variable but controllable critical near miss scenarios. This testing is critical to the proper development and validation of CAV products and will serve AV developers' needs for both hardware and software. ACM's testing assets will also be critical to the work of government agencies and academic researchers collaborating on safety, mobility, and energy aspects of a CAV-based transportation system.

The American Center for Mobility program will focus on three activity pillars that are critical to CAV safety: testing/validating, standard setting, and education. CAV technology, including communication, infrastructure, and cyber security, is developing very rapidly. All three of these key "pillar" activities should be advanced simultaneously to ensure that the technology is developed to maximize safety, mobility, energy, transportation equity, and other benefits.

ACM is working with other facilities, government agencies, academia, industry, and like-minded experts, to share best practices and innovations for testing operator safety, facility design concepts and details, facility operational best practices and lessons learned, data acquisition and analysis system concepts, and testing and analysis equipment best practices and standards. ACM is convening operators and designers of other test facilities to lead the effort in the formation of

this Community of Practice. ACM is partnering with standards organizations, such as SAE International, IEEE, ISO, NIST, ASTM, and others in these sharing discussions at the appropriate time, and will work with those bodies to enable voluntary standards as appropriate.

ACM's mission includes the acceleration of these voluntary standards through convening and the creation of laboratories designed specifically for AV testing and standardization. ACM has partnerships in place with SDOs which will enable an accelerated process that will allow the standard setting experts to convene at ACM and participate in testing and demonstrations that inform the strategy, details, and ultimately decisions on the standards that are created. ACM provides a unique venue to contemporaneously develop and validate standards in rapid cycles and serve as a convening center where industry, government, SDOs, and other interested stakeholders can collaborate and accelerate the development of critical standards.

Through its ability and focus to convene technical experts, numerous automotive development users, and standards bodies, ACM will establish a user group to develop a uniform approach or voluntary standard to data sharing. While it is unlikely that any manufacturer or tester will share all of its vehicle and incident data, this user group will act to establish a process to share noteworthy scenarios, and to define a subset of data and data retrieval/access methods, that they can agree to share. ACM will fully protect consumer and public privacy and security, and will take steps to ensure that any data or information sharing activities do not violate, hinder, or compromise integrity of any consumer privacy/security agreements or arrangements put in place by manufacturers, testers, agencies, public entities, or by ACM itself. Similarly, ACM commits to maintaining the confidentiality and security of proprietary confidential business information and data on behalf of its users, testers, and private partners.

ACM will lead the formation of a specific Community of Practice focused on safe CAV testing, as a proposed subgroup of the International Committee for Proving Ground Safety (ICPGS) established to enable the rapid sharing of information, best practices, and data including the following aspects: Best safety practices specific to CAV testing, including vehicles, infrastructure and communication; driver training (remote and in vehicle); safe conduct of testing and operations; safety management plans and protocols; common safety incident reporting protocol; and common data format and agreement to share non-proprietary/non-confidential data.

ACM fully supports the establishment of a network of experts and commits to providing engaged expertise through comments, meetings, workshops, and more formal activities including volunteered participation in an expert committee. In addition, the ACM facility will serve a very important purpose to educate the current and next generation of engineers, policy-makers, lawyers, and strategists and, in league with a consortium of universities and community colleges, will develop a curriculum to ensure that expertise is generated and available for hiring or appointment throughout industry, government, and academia.

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