CONTRA COSTA
transportation
authority

MEMORANDUM

Date: November 26, 2018

To: Rules Docket Clerk, National Highway Traffic Safety Administration

From: Contra Costa Transportation Authority

RE: **Docket Number NHTSA-2018-0092**

The Contra Costa Transportation Authority (CCTA) is pleased to submit the following comments regarding a possible Pilot Program for Collaborative Research on Motor Vehicles with High or Full Driving Automation, Docket Number NHTSA-2018-0092. CCTA is a public agency formed in 1988 to manage Contra Costa County's voter approved transportation sales tax program and to do countywide transportation planning.

CCTA and its key partners launched GoMentum Station in January of 2015, which has since evolved into a nationally and internationally recognized test bed site for cutting-edge Connected and Autonomous Vehicle (CAV) technology. Since its inception, the GoMentum Station Program has been at the forefront of planning and research for high level and fully automated vehicles, such as SAE (Society of Automotive Engineers) Level 4 and Level 5 CAV prototypes. GoMentum Station facilitates a collaborative partnership among technology innovators, Original Equipment Manufacturers (OEMs), traffic engineers, transportation planners, and other partners to enable a secure and safe testing and operational environment.

Through implementation of the GoMentum Station Program, CCTA is helping to incubate a new generation of technology that has the potential to revolutionize transportation infrastructure with the ultimate goal of introducing CAV technology safely on public roads to improve safety by reducing traffic fatalities, reduce congestion, enhance mobility, and improve productivity. CCTA has valuable first-hand knowledge, experience, and lessons learned related to the on-going research and development of CAV technology.

CONTRA COSTA
transportation
authority

CCTA is excited to learn that National Highway Traffic Safety Administration (NHTSA) is considering the establishment of a nation-wide pilot program that will enable NHTSA to facilitate, monitor, and learn from collaborative research related to testing and development of autonomous vehicles. We believe that NHTSA's early involvement into the pilot program(s) and testing process would have multiple industry benefits. It would help to establish a clear and consistent structure and foundation for the future of standardization, development, and deployment of Level 4 and 5 vehicles nationwide. For existing pilots, NHTSA involvement will help to guide planning and development by vehicle manufacturers to align expectations and help to reduce the investment risks involved in research of development of cutting-edge technology related to Automated Driving Systems (ADS).

CCTA supports the United States Department of Transportation's (USDOT) Connected and Automated Vehicle Policy 3.0 whereby it is the Department's policy to avoid favoring one technology over another and to allow CAVs to develop without burdensome regulatory requirements. This is good approach to let manufacturers research and test various technology architectures that under development and supports innovative design of technology in the free market. However, CCTA believes that there is a need for additional involvement from NHTSA and the USDOT to set a framework to define the basic safety, performance, functionality, and security requirements for vehicles that are intended for public roads to gain a real-world conditions experience. Additionally, there is an opportunity for more involvement from NHTSA to include guidelines for compliance certification, compliance verification, and enforcing compliance with the safety standards of Level 4 and 5 vehicles.

Beyond the testing and development of CAV vehicles in the controlled environment, such as test beds and factories, there will be a need to perform a series of tests and verification and validation tests in real world environments. The exemption for vehicles that do not comply by the Federal Motor Vehicle Safety Standards (FMVSS), was a good temporary solution to introduce innovative mobility solutions and initiate multiple test pilots for the development of level 4 and level 5 (prototype) vehicles. In order to address the new technology that is hitting the market, there is a need for NHTSA to expand the FMVSS regulations to cover the hardware and software used in ADS such as cameras, lidars, radars, computer systems, and their software technologies to identify bare minimum reliability, safety, security, and redundancy requirement for such components and the compliance verification or certification process. To date, the self-driving or ADS enabled driving can be tested and certified by states, DMVs, and local agencies. Testing and verification environments are available for vehicle manufacturers take their vehicles with the latest version of self-driving system and have them be examined by a DMV instructor as well as be tested against a series of scenarios.

As far as we are aware, there are no fully tested and ready Level 4 and Level 5 vehicles that exist today, that can safely drive on the nation's public roadways and transport goods and passengers. There are however, fully automated trains and aircrafts with similar Level 4 and Level 5 vehicle concepts that have been safely functioning in controlled or semi-controlled environments. We believe that there is knowledge and experience from the railroad and aviation industries that could serve as a model for system engineering, stand-alone device testing, subsystem and system testing of Level 4 and CAV ADS. Bay Area Rapid Transit (BART) Automatic Train Operation (ATO), Caltrain Positive Train Control (PTC), and aircraft's Auto Pilot navigation and fail-safe systems can be learned from and leveraged to set basic requirements for future Level 4 and Level 5 vehicles.

Additionally, there are currently Level 4 and Level 5 OEM prototype vehicles that are being tested around the world on private and public roadways that can be further developed and refined to achieve a final product suitable for public roadways. CCTA and GoMentum Station are currently leading a Shared Autonomous Vehicle (SAV) program that is utilizing a Level 4 vehicle and performing testing, verification, and validation tests to see if the vehicle can perform expected functionalities on public roadways in a safe manner. The FMVSS exemption allowed the pilot program to be able to start testing of the Level 4 vehicles without driving wheel, gas and brake pedals. We understand and agree that vehicles with this type of exemption and that are currently under testing are not to provide services and/or transport members of the public, passengers, and goods. Lack of clear direction and current regulations with regards to whether such vehicles will be allowed to operate, per FMVSS regulations in the future, is slowing the investment and development process of manufacturers and potential investors due to the level of risks.

Increased involvement by NHTSA could include research and testing to see if the navigation and steering system of such vehicles can meet the standards and requirements of the vehicles with the steering wheel. If they cannot perform the same, there will be a need for the identification of performance metrics for manufacturers to achieve. Apart from mechanical systems, the concepts used in the development of the prototypes may not be fail safe; what will happen if the on-board computer fails and no other on-board computer is available to take over and the vehicle is in self-driving mode and driving at 40 mph or what if a sensor fails to detect and obstacle or object. Setting the bare minimum redundancy requirements for the sensors and electronic systems on-board can improve reliability of such vehicles that are under development.

Within the pilot programs, we have performed risk analysis and identified possible mitigation approaches to minimize the risk of failures when testing on public roadways by preparing the test area and placing signages, markings, road-closures (when needed), Dedicated Short Range Communication (DSRC) radio and other ways to make the road safe. We think that infrastructure needs to be ready for future Level 4 and 5 vehicles and we were collaborating with industry experts such as traffic controller manufacturers, DSRC radio manufacturers and Connected Vehicle experts, 4G and 5G industry experts, Intelligent Transportation Systems (ITS) experts, Manual on Uniform Traffic Control Devices – FHWA experts, Industry of Transportation Engineers (ITE) and vehicle manufactures to exchange information related to if improvements needed to lane markings, signages, signals, and communications infrastructures for future operation of the vehicles.

One of the legal gaps we faced with multiple pilot projects in which we were involved, was the lack of understanding of who is the owner of the vehicle and who is the responsible party in the event of an accident. The vehicles that don't meet the FMVSS requirements are not registered in the commerce system, and therefore, cannot be sold. For the pilot programs, there may be need for contracts between the vehicle manufacturers and pilot project sponsor or investor to lease or provide the vehicle for testing. We think that NHTSA and national DMVs can create a task force as part of the proposed Pilot program in order to further research and identify solutions for issues, such as: the owner and responsible party of the rented or leased under the test vehicle to remain the manufacturer who also need to provide trained operators for testing the vehicle while the investor or program sponsor is also secured similar to the way lenders money is secured.

CONTRA COSTA
transportation
authority

We think that more than gathering data from tests, NHTSA's participation in some of the nation's existing Pilot program can assist with knowledge transfer between the Pilots that can lead toward successful development and implementation of standards, processes, and verification processes that can result in increase of investment into Level 4 and 5 vehicles and more involvement from manufactures that can result in reaching the fully tested and functional Level 4 and 5 vehicles.

We think in addition to FMVSS, certification and verification processes, a state agency should be identified to monitor Level 4 and Level 5 vehicles testing on the public roadways to verify that the testing and operations are performed under the specific conditions defined by the manufacturers and approved by NHTSA experts. For example, monitor that low-speed vehicles operate on roadways with speed limit of 40Mph or lower.

Following are our responses to some of the questions we find relevant with CCTA's SAV program and GoMentum Station programs:

1) Question 1. What potential factors should be considered in designing the structure of a pilot program that would enable the Agency to facilitate, monitor and learn from on-road research through the safe testing and eventual deployment of vehicles with high and full driving automation and associated equipment?
   a) *As mentioned above, we do support the idea of NHTSA to establish and design a pilot program. From our point of view, the key part is to establish a collaborative program that has multiple task force groups concentrating on multiple aspects such as followings:*
      i) *NHTSA and DMVs can exchange information and enlighten the public with on-going webinars that describe the responsibility of agencies when it gets to the concepts, mechanics, electronics, software, and driving skills of Level 4 and Level 5 Vehicles and ADS.*
      ii) *The knowledge exchange and participation in some of the existing programs to learn the latest from the on-going tests around the nation, gathering data, hearing their issues, etc.*
      iii) *Bringing experts from other industries into the public webinars that can share lessons learned from automated systems and auto pilot of railroad and aviation and if they can be used to set bare minimum requirements in the standards.*
      iv) *Bringing states and local agencies to gather knowledge and information about the improvements to infrastructure that may be needed that can prepare the roads for future and deployment of Level 4 and 5 vehicles. Industry experts such as traffic controller manufacturers, Dedicated Short Range Communication (DSRC) radio manufacturers and Connected Vehicle experts, 4G and 5G industry experts, Intelligent Transportation Systems (ITS) experts, Manual on Uniform Traffic Control Devices – FHWA experts, Industry of Transportation Engineers (ITE) and vehicle manufactures to exchange information related to if improvements needed to lane markings, signages, signals, and communications infrastructures for future operation of the vehicles.*
      v) *In addition, the NHTSA pilot program can invite vehicle manufacturers to a challenge and winners get some research fund and selected to participate in the program with goal and vision of developing the vehicle of the future or some funding can be assigned to some of the existing pilots that NHTSA feels they can be helpful with achieving the agency's goals and objectives.*

vi) *Testing experts to exchange information on how to make the test environment safe on public roadways for the Level 4 or 5 to perform real-world tests. How to address expectations of public while tests are being conducted, if the safety of others such as pedestrians, vehicles, bikes, etc. is considered. If the testing is performed off peak to minimize impact to roadway operations. What are the lessons learned, where data gathered from other real-world testing is shared, how to interpret the shared data, what were the test scenarios and use cases.*

b) *for the pilot program structure, following key factors can be considered:*
   i) *Safety – safety of the vehicle, safety of the others including vehicles, peds, bikes, etc.*
   ii) *Navigation – Driving, localization, mapping, visibility, etc.*
   iii) *Traffic Laws - Comply with public road rules/law, right-of-way, etc.*
   iv) *Critical error – hit any obstacle or object, driving on oncoming traffic lanes, disobey traffic light, etc.*

2) Question 2. If NHTSA were to create a pilot program, how long would there be a need for such a program? What number of vehicles should be involved? Should NHTSA encourage the conducting of research projects in multiple locations with different weather conditions, topographical features, traffic densities, etc.?
   a) *The length of the program depends on the goals and objectives; the program may continue until the goals are achieved or the goals can be set based on other constraints such as agency's policies or available funds for specific goals. Based on our experience, the program in the scale that NHTSA wants to create need to be functional for minimum of five years or goes as long as there is no longer a need for such a program when all the goals are archived. As there is need for testing vehicles in different weather, terrain, topographical, traffic densities, days and times of the year. As we have slightly different kind of signages, road markings, road designs, etc. between cities and states, there is a need for pilot research in multiple geographical areas that all of them can exchange knowledge and between each other.*
      i) *An example of a 5- year pilot program may include: A designated city or cities where multiple modes of CAVs can be scaled in numbers to integrate into the mobility network. The pilot should have three phases where vehicles should demonstrate success as evaluated by a set criteria at each stage in order to be certified to move on to the next stage and finally be ready for commercial use in the final phase (phase 4). The four phases are as follows: 1. Closed/private property testing 2. Public fixed route testing and 3. Autonomous public road testing 4. Certified for commercial use/deployment.*
      ii) *Each manufacturer chosen for the vehicle procurement should have 4 vehicles testing at stage one and should be able to scale in the number of vehicles it will deploy in the program (not to exceed 50 vehicles before stage 4).*
      iii) *The test city or cities should test in diverse road conditions, weather conditions and mixed traffic scenarios.*

3) Question 3. What specific difficulties should be addressed in designing a national vehicle pilot program for vehicles with high and full driving automation either through the exemption request process relevant for FMVSS or more broadly related to other areas of NHTSA and/or other authorities.
   a) *As mentioned earlier, we think the exemption idea worked great so far with initiation of multiple test pilots and development of prototype level 4 and level 5 vehicles. We all think that NHTSA*

has to further improve the FMVSS regulations to cover the hardware and software used in ADS such as cameras, lidars, radars, computer systems, and their software technologies to identify bare minimum reliability, safety, security, and redundancy requirement for such components and the compliance verification or certification process. The self-driving or ADS driving skills can be tested and certified by states, DMVs, and local agencies where test and verification environments be available in test-beds and vehicle manufacturers take their vehicles with latest version of self-driving system there to be examined by DMV instructor verses series of scenarios. The FMVSS exemption allowed the pilot program to be able to start testing of the Level 4 vehicles without driving wheel, gas and brake pedals. We understand and agree that vehicles with exemption and under the test are not supposed to provide services and/or transport members of public, passengers, and goods. However, lack of clear direction and regulations in regard to weather such vehicles will be allowed per FMVSS regulations in future is slowing the investment and development process of the investors and manufacturers toward such vehicles because of the risks involved. NHTSA more involvement can include research and study to see if the navigation and steering system of such vehicles can meet the standards and requirements of the vehicles with the steering wheel and if they can perform the same and if not, identify the performance metrics for manufacturers to achieve. Apart from mechanical systems, the concepts used in the development of the prototypes may not be fail safe; what will happen if the on-board computer fails and no other on-board computer is available to take over and the vehicle is in self-driving mode and driving at 40 mph or what if a sensor fails to detect an obstacle or object. Setting the bare minimum redundancy requirements for the sensors and electronic systems on-board can improve reliability of such vehicles that are under development.

4) Question 4. How can existing statutory provisions and regulations be more effectively used in implementing such a pilot program?
   a) *The operation of an Autonomous Vehicle is much more than just a couple of pass or fail procedures to be verified. If a vehicle successfully demonstrates the ability to turn left at a signalized intersection, still left turn under various conditions and other intersection need to be tested and at the end it is hard to say if the left turn ability of the ADS can be performed the same at every intersection. The way that we look at it, is the same as practice the necessary driving skills to pass the "road test" for new drivers. As a teenager/new driver, before applying for your provisional driver's license, you'll need to complete certain hours of supervised driving practice. The pilot program is similar to the driving practice in a controlled environment, no passenger, having the operator inside the vehicle at all times, to confront the real scenarios and challenges on the public roads as much as we could. However, the outcome of the pilot program testing does not guarantee the AV to be perfect and completely tested and will not have any incidents later. The pilot programs are mainly there as an incubator and starter until a fully verified and validated system exists. Manufacturers may learn from the pilot program outcomes and once the basis are defined, the next steps need to be taken by manufacturers in the free market to further improve their ADS systems.*
5) Question 5. Are there any additional elements of regulatory relief (e.g., exceptions, exemptions, or other potential measures) that might be needed to facilitate the efforts to participate in the pilot program and conduct on-road research and testing involving these vehicles, especially those that lack controls for human drivers and thus may not comply with all existing FMVSS?

a) *We think the exception/exemption was a good approach to start multiple pilots. There may be a need to increase monitoring over the pilots that has exemption from FMVSS. In anyway, we think that there shouldn't be a way for manufacturers to abuse the regulatory relief and using under the test vehicles to transport members of public including kids, elderlies, or other residents and putting them at risk. In addition, we think that operation of the vehicles under the test at public roads need to be well communicated to public and the necessary steps to minimize the risk and preventing impact to day to day operation should be considered such as road closures when needed, placing signages, and/or performing tests during off peak hours.*
b) *We think the FMVSS regulations exist for good and that all vehicles need to meet the safety standards as much as possible. Testing with a vehicle that doesn't meet the safety codes not only can endanger the test operators that are testing it on public road but also can increase risk for other vehicles, pedestrians, bikes, etc. Our pilot program has minimized the time the vehicles with exemption to bare minimum to reduce such risks. However, we think NHTSA can enlighten manufacturers that FMVSS is mandatory and vehicles with exemption should plan accordingly to meet the FMVSS expectations and work with NHTSA to plan for it.*

6) Question 6. What vehicle design elements might replace existing required safety equipment and/or otherwise enhance vehicle safety under reasonably anticipated operating conditions?
   a) *There are a lot of FMVSS elements that may need to be reevaluated and reconsidered, following is a summary based on what we have learned so far:*
      i) *Standard No. 203: Impact protection for the driver from the Steering Control System.*
      ii) *Part 570 – Vehicle-in-use Inspection Standard: brake system, steering, and suspension.*
      iii) *Standard No. 204: Steering Control Rearward Displacement.*
      iv) *Part 571/ Standard 101- Crash Avoidance, Crash Worthiness and Post-Crash Standards*
      v) *Part 571/ Standard 111- Review Mirrors*
      vi) *Part 571/ Standard 124- Accelerator Control Systems*
      vii) *Part 571/ Standard 212- Windshield Mounting*
      viii) *Part 595- Retrofit On-Off Switches for Airbags*
      ix) *Part 575- Consumer Information Regulations*
      x) *Part 571/ Standard 121- Air Brake Systems*
      xi) *Part 571/ Standard 105-Hydraulic and Electric Brake Systems*
      xii) *Part 571/ Standard 135- Light Vehicle Brake Systems*
      xiii) *Part 571/ Standard 125-Warning Devices*
      xiv) *Part 571/ Standard 103- Windshield Defrosting and Defogging Systems*
      xv) *Part 571/ Standard 104-Windshield Wiping and Washing Systems*
      xvi) *Part 567-Certification Regulation*
      xvii) *Part 571/ Standard 207- Seating Systems*
      xviii) *Part 571/ Standard 208- Occupant Crash Protection*
      xix) *Part 577- Defect and Noncompliance Notification*
      xx) *Part 579- Defect and Noncompliance Responsibility*
      xxi) *Part 580- Odometer Disclosure Requirements*
      xxii) *Part 583- Automobile Parts Content Labeling*

CONTRA COSTA transportation authority

7) Question 7. What types of performance measures should be considered to ensure safety while allowing for innovation of emerging technology in vehicles with high and full driving automation participating in a pilot program?

   a) *We think the performance measures and metrics should be defined by NHTSA based on the measuring based on the human driver's response time with a regular vehicle that meets the safety standard and those performance measures gathered and used as a goal for the ADS systems. Such measures can be the response time from the time an obstacle is noticed and the distance or time to come to complete stop and/or the turning angles, maneuvers with different speeds at various sharp or regular corner turns.*

8) Question 8. How should the Operational Design Domains of individual vehicle models be defined and reinforced and how should Federal, State and local authorities work together to ensure that they are observed?

   a) *We think the overall concept and basis for Operation System of the ADS need to be defined to some extend as a result of collaboration effort between agencies. We all think that NHTSA has to further improve the FMVSS regulations to cover the hardware and software used in ADS such as cameras, lidars, radars, computer systems, and their software technologies to identify bare minimum reliability, safety, security, and redundancy requirement for such components and the compliance verification or certification process. The self-driving or ADS driving skills can be tested and certified by states, DMVs, and local agencies where test and verification environments be available in test-beds and vehicle manufacturers take their vehicles with latest version of self-driving system there to be examined by DMV instructor verses series of scenarios.*

   b) *Apart from mechanical systems, the concepts used in the development of the prototypes may not be fail safe; what will happen if the on-board computer fails and no other on-board computer is available to take over and the vehicle is in self-driving mode and driving at 40 mph or what if a sensor fails to detect an obstacle or object. Setting the bare minimum redundancy requirements for the sensors and electronic systems on-board can improve reliability of such vehicles that are under development.*

9) Question 9. What type and amount of data should participants be expected to share with NHTSA and/or with the public for the safe testing of vehicles with high and full driving automation and how frequently should the sharing occur?

   a) *We think there should be website and platform that Pilot programs and manufacturers can access and upload the result of their tests.*

      i) *Testing experts to exchange information on how to make the test environment safe on public roadways for the Level 4 or 5 to perform real-world tests. How to address expectations of public while tests are being conducted, if the safety of others such as pedestrians, vehicles, bikes, etc. is considered. If the testing is performed off peak to minimize impact to roadway operations. What are the lessons learned, where data gathered from other real-world testing is shared, how to interpret the shared data, what were the test scenarios and use cases.*

ii) *Beyond data points for safety, the participants should be expected to share traffic data in the testing environment in order to create a "dynamic map" for the testing environment. This map allows for additional predictive analysis and modeling means for all ecosystem partners to improve V2V interactions, V2I interactions and human-machine interface.*

10) Question 10. In the design of a pilot program, how should NHTSA address the following issues, confidential business information, privacy, data storage and transmission, data retention and reporting, other elements necessary for testing and deployment?

a) *There can be local pilots that are storing confidential data and business information. Another option is the platform for data sharing allows the pilot programs and manufacturers to mark or remove confidential or business-related information the data shared. Data storage can happen at secure cloud location or multiple local pilot locations. Data retention policies should allow data to be stored or archived until few years after the Pilot Program completed.*

11) Question 11. In the design of a pilot program, what role should be played by the 12 safety elements listed in A Vision for Safety as well as Failure risk analysis and reduction during design process (functional safety)? Objective performance criteria, testable scenarios and test procedures for evaluating crash avoidance performance of vehicles with high and full driving automation? Third party evaluation? Failure risk reduction? Crash avoidance performance of vehicles with high and full driving automation? Occupant/non-occupant protection from injury in the event of a crash (crashworthiness)? Assuring safety of software updates? Consumer education? Post deployment Agency monitoring? Post-deployment ADS updating, maintenance and recalibration? Are there any other elements that should be considered?

a) *We think all of these elements have a key role.*

14) Question 14. What types of terms and conditions should NHTSA consider attaching to exemptions to enhance public safety and facilitate the Agency's monitoring and learning from the testing and deployment, while preserving the freedom to innovate, including terms and conditions for each of the subjects listed in question 13? What other subjects should be considered, and why?

a) *Additional terms to accompany exemptions may include:*

i) *developing a national performance-based assurance guideline that assesses the safety of vehicles against nationally agreed upon safety criteria, in conjunction with removing outdated legal barriers that the current FMVSS regulations express.*

b) *A third-party technical verification organization at the State level that ensures the vehicles being tested are in compliance with new safety criteria that address:*

ii) *General Requirements: physical security measures, cyber security measures, liability and insurance obligation, cooperation and coordination with authorities and institutions, and cooperation with emergency and police agencies;*

iii) *Requirements for Operators: Test Drivers, Test Conductors, and Test participants*

iv) Requirements for the Vehicle: general requirements for operating in mixed traffic, data recording, data protection, net security, processes for take over of automated/interconnected systems, error warning, and software level