Department of Motor Vehicles

Public Workshop
Autonomous Vehicles

Tuesday, January 27, 2015
10:00 AM – 2:00 PM

Assembly Room*
Department of Motor Vehicles Headquarters
2415 First Avenue
Sacramento, California

Facilitator:
Brian G. Soublet
Chief Counsel
Department of Motor Vehicles

I. Opening
• Introductions
• Housekeeping
• Background and Workshop Objective

II. Workshop Discussion
• Autonomous Vehicle Safety Certifications
  – Manufacturers’ current processes for evaluating autonomous vehicle safety
  – Manufacturers’ criteria for deciding an autonomous vehicle is ready for public operation
  – Development of common safety standards, testing regimens, and review processes
  – DMV verification of manufacturers’ safety certifications
  – DMV approach to verifying manufacturers’ compliance with safety requirements
• Compliance with Federal Motor Vehicle Safety Standards (FMVSS)
  – Manufacturer testing for compliance with FMVSS
  – DMV verification of manufacturers’ compliance with FMVSS
• Use of Test Data
  – Use of test data to inform regulatory process
  – Use of test data to validate safety certifications made by manufacturers

III. Closing Remarks and Next Steps

Please see attached pages for additional details on the workshop agenda and discussion topics.

*The Assembly Room is located in a secure area of the building so please check-in at the security station. Parking near the headquarters complex is limited so please plan accordingly.
BACKGROUND
Senate Bill 1298 (Chapter 570; Statutes of 2012) enacted Vehicle Code Section 38750 which requires the Department of Motor Vehicles (DMV) to adopt regulations establishing certain vehicle equipment requirements, equipment performance standards, safety certifications, and any other matters that the department concludes is necessary to ensure the safe operation of autonomous vehicles on public roads, with or without the presence of a driver inside the vehicle.

In July 2014, the DMV released a Request for Information (RFI) to receive vendor input regarding the capabilities of any entities with an interest in conducting third-party functional safety reviews and safety certifications of autonomous vehicles or autonomous technology. DMV received RFI responses from four entities. Based on the information provided, the department has not made a determination whether any of the proposals form an adequate basis for incorporating an application review process into regulation. (Please see Attachment 1 for excerpts from the RFI responses received by the department.)

WORKSHOP OBJECTIVE
The objective of this workshop is to receive substantive input from interested parties, and specifically persons with technical expertise in the testing and certification of vehicle safety, to facilitate the DMV’s development of the post-testing deployment regulations. This workshop will focus on topics related to the safe operation of autonomous vehicles, specifically:

- Certifications by manufacturers that autonomous vehicles can be operated safely on public streets by the general public.
- How DMV will determine the validity of those certifications in order to approve a manufacturer’s application for the post-testing deployment of autonomous vehicles.

This workshop will not address other topics that may fall under the scope of the operational regulations, such as: financial responsibility requirements, vehicle registration requirements, driver licensing requirements, and information privacy requirements.

WORKSHOP DISCUSSION TOPICS
I. Autonomous Vehicle Safety Certifications
In discussing the safety of autonomous vehicles, the DMV is considering both the competency and functional safety of the autonomous vehicle. Competency focuses on the autonomous vehicle’s ability to safely operate under the range of conditions encountered on public roads, including: executing critical driving maneuvers, obeying traffic laws, and responding to hazardous driving situations. Functional safety focuses on the autonomous vehicle’s ability to deal with and respond to internal faults and failures (software, electrical or mechanical components, etc.).

With many manufacturers currently developing and testing autonomous vehicles, the department seeks information on:

A. What standards, testing regimens, functional safety reviews, or other processes are being used to by manufacturers to evaluate the safety of their autonomous vehicle?

B. What criteria have manufacturers established to determine that an autonomous vehicle has been adequately tested and is ready for operation by the public?

C. Which of these development or testing practices could be incorporated into a common set of autonomous vehicle safety standards, testing regimens, or review processes?
Except for testing as provided for in the testing regulations in Article 3.7, of Title 3, California Code of Regulations, an autonomous vehicle shall not be operated on public roads until the manufacturer submits an application to the DMV and that application is approved by the department.

D. What information should the DMV request as part of an application for a post-testing deployment to validate safety certifications made by the manufacturer?

E. How can the state best verify compliance with any safety requirements established in the post-testing deployment regulations?

II. Compliance with Federal Motor Vehicle Safety Standards

As part of their application for post-testing deployment, manufacturers will need to certify to that their autonomous vehicle meets Federal Motor Vehicle Safety Standards (FMVSS), and that the autonomous technology does not make inoperative any FMVSS for the vehicle’s model year.

F. What approach are manufacturers taking to test that their autonomous vehicle complies with FMVSS?

G. What information should DMV request as part of the application for post-testing deployment to verify compliance with FMVSS?

III. Use of Test Data

The autonomous vehicle testing regulations adopted in May 2014 require that manufacturers submit an annual report on instances when a disengagement of the autonomous mode was required, as well as to report any accidents involving an autonomous vehicle within 10 days after the accident.

H. In addition to these data elements, what other testing data could be used to inform the rulemaking for autonomous vehicles?

I. How can the department use test data to validate safety certifications made by the manufacturers?
ATTACHMENT 1: EXCERPT FROM AUTONOMOUS VEHICLE RFI RESPONSES

RFI Question: How would you propose to independently certify the functional safety of autonomous vehicle technology in the absence of specific standards for these systems? What does a functional safety certification actually mean in this context?
   a. Approximately how long does this process take?
   b. What is your estimate of the cost to conduct the process and make the certification?

Respondent 1: Battelle

Automotive manufacturers need to comply with ISO26262 while still controlling costs for consumers. The methods that auto manufacturers use or plan to use for applying ISO 26262 are unknown. As autonomous technology develops, the cost of enhancing safety will require redundant or back-up systems, which may impact the cost of vehicles by increasing expenses for additional hardware and software development. An economical approach may require scaling the costs of safety redundancies, but this will have to occur without compromising safety. Our method will allow for evaluating functional safety given the wide variety of approaches that manufacturers may take to balance costs while providing safe travel.

There would be two stages to a Battelle certification of functional safety. The first would rely on identifying safety cases, which would be derived from operational end-user scenarios (e.g., changing lanes, following a trajectory, etc.). The second stage would be to verify safety redundancy by evaluating the function of all redundant back-up elements while autonomously performing relevant safety case maneuvers. This approach assumes that most vehicles contain redundant back-up sensors that are operational in an accessible failure mode that would allow for activating and deactivating back-up systems.

Stage 1 – Safety Cases: Battelle would begin the certification process by identifying safety cases that stem from safety critical operational scenarios. The safety cases would consist of end-user scenarios relevant to the specific autonomous vehicle that is to be tested. To optimize our efforts the scenarios would be selected to test autonomous operations under market use cases (e.g., autonomous highway travel, or autonomous shuttle operations, etc.). The Battelle functional safety evaluations would rely on the concepts and techniques for functional safety as defined in ISO 26262.

Stage 2 – Redundancy verification: The second approach would leverage the requirements of ISO 26262 regarding redundant backup systems, failure detection and informing operators of failure, and the availability of the autonomous control given a controlled failure of a subsystem. The precise methods and hardware are certainly under the decision making of the manufacturers, and we believe the functional safety can be evaluated using methods that rely on safety cases built around operational use-case scenario identified in Stage 1. We would simulate the scenarios identified in Stage 1 while systematically testing redundant safety subsystems.

In summary, our approach would be to identify pertinent use cases and the safety relevant situations within them. Then we would systematically evaluate back-up systems under simulated pertinent safety situations. A primary goal would be to ensure that on-road there is minimize risks to other road users and the operators of the autonomous vehicle.

It would take approximately six (6) to nine (9) months per evaluation with an estimated cost per evaluation of $100,000.
Respondent 2: SGS-TÜV Saar

- SGS-TÜV Saar works in the field of Functional Safety for: Automotive, Software, Automation, Machinery, Process Control, Railways, Medical and Household Devices. It allows to see a problem with a different angle.

- SGS knows a set of abstracted Safety Principles to be applied for investigations of products with functions not developed according to safety standards.

- SGS always follows best practice:
  - IEC 61508 delivers the basic principle.
  - ISO 26262 is specific automotive standards and is always applied as far as state of the art and as far as applicable.

- In case the IEC 61508 and ISO 26262 is not sufficient: SGS assesses the development by application according to state of the art.
  - Example: For a system like autonomous driving with a huge number of functions a model based approach is expected.

- Assessment following an internal accepted standard like IEC 61508 or ISO 26262 is cost-efficient in general.

- Assessment according to Safety Principles and best practice technologies are about 50% more expensive because of assessing the applied technologies and their methods for compliance with Safety Principles.

- Note: In conformity with the state of the art, several system manufacturer already can deliver an assessment report by an accredited body \(\rightarrow\) reduced efforts on vehicle level.

- Assessment duration of a standard conforming new developed item of average complexity lasts about 500 to 600 hours.

- Assessment of an item developed according to the best practice technologies will last about 50% longer due to development recursions to be taken for compliance with safety principles at the end.
Respondent 3: Transportation Research Center Inc. and The Ohio State University

We would define standardized scenarios that show the utility of the autonomous functionality (e.g. highway based scenarios of convoys, de-merging, passing convoys, splitting, etc.; urban scenarios of car following, intersection behavior, lane change, etc.; individual event handling, etc.). Based on these scenarios, we would generate exercise or stress each component/module (as far as that is possible) of an autonomous vehicle and also define testing scenarios that evaluate the overall functionality and robustness of mid-level and upper-level functionality, also consider human-in-the-loop and HMI issues.

To build such a test you have to identify quantitatively

a. minimum levels of functionality, which in this case has a lot to do with describing quantitatively the external environment and situation

b. specific failure modes for which to test

   a. Approximately how long does this process take?

   This depends on how detailed the scenarios are established and the “coverage” of the functionality. If the requirement is for “only truck convoys, only controlled access highways” it could be reasonably quick. If it is for “all vehicles with two or more lane controlled access highways” this too may be established in a reasonable time. Anything further can be considered.

b. What is your estimate of the cost to conduct the process and make the certification?

   Negotiable. Depends on scope coverage, depends on detail.

Respondent 4: TÜV SÜD Auto Service

We perform approvals and certifications of autonomous vehicle technology on the basis of

- ISO 26262 or IEC/EN 61508,
- UN/ECE regulations (e.g. 13 and 79 concerning braking and steering systems) and
- National road traffic licensing regulations (e.g. FMVSS and CMVSS).

If necessary, we obtain special permits by federal, state or municipal authorities on behalf of our customers.

a. The process takes about 3 months. Usually, we are involved from our customers in the concept phase of the development of autonomous vehicle technology (according to ISO 26262). Therefore approvals and certifications are performed parallel to the development.

b. In our experience the costs to conduct the process and make the certifications are between 70,000 and 80,000 Euro for one system. The before mentioned costs do not include travel expenses and special support by our U.S. staff (e.g. identification of special local situation and requirements or communication with local authorities).