AV1005

TESLA

Model S Autopilot Training

General Training Required for All Prototype Vehicles
Before any employee is allowed to drive a Tesla-owned Model S they must complete a general training. A stricter set of rules are required for prototype vehicles. The process is described in this section.

1. Approval process prior to training:
    a. The first step in the process is for a manager to identify that their employee has a business need to drive vehicles from the Model S prototype fleet.
        i. This typically occurs when the employee is responsible for some portion of testing (rather than business needs other groups might have for their vehicles such as customer test drives, rides for potential suppliers or use in marketing events).
    b. The manager needs to write up a description of the kind of work the employee needs to do that requires driving access to the Model S prototype fleet and send it to David Lau (Director of the group that owns and manages this fleet of cars) for his approval.
    c. David may respond to the manager with any specific follow-up questions about the type of work described and asks the manager to vouch for the judgment of the employee in question.
    d. If the above information is satisfactory, David approves the person for training.
    e. Additional requirements:
        i. Employee must hold a current U.S. driver's license
        ii. Employee must be a full-time employee – interns and contractors are not allowed to drive these vehicles.

2. Training process:
    a. The training is broken into two classes:
        i. Code of Conduct
            1. This is a classroom course focused on the company's expectations for employees behavior in the car and highlights particular safety concerns unique to prototype vehicles
            2. Typically runs between 30-60 minutes and is required before the next step.
        ii. Model S Walkthrough and Drive Test
            1. This is a small class limited to 5 people per session and focused on teaching the employee an overview of the vehicle controls and behavior, much like our delivery team does for customers purchasing a vehicle.
            2. The second part of this class is a relatively short drive test whereby the instructor rides along with the employee on a short pre-determined route and is asked to make a (albeit subjective) assessment as to whether the employee appears to be a safe, responsible driver

a. A driver can "fail" the drive test by doing anything that calls into question their ability to safely operate the vehicle, to operate the vehicle using good judgment, or to calmly and intelligently handle any failure that might occur out on the road.
b. A driver who fails the drive test is given a second drive test by an alternate instructor (who is not supplied any information about what the concerns were from the first instructor) to verify whether the opinion of the first instructor is echoed by the second.
    i. In most cases we've experienced, if an employee fails the drive test once, they fail it a second time with the alternate instructor. We've weeded out employees who have driven too aggressively, as well as employees who are too tentative or don't appear confident handling the vehicle.
    ii. In rare cases, if the two instructors disagree, we let the two of them and the employee's manager decide on the best course of action.

b. Once the Code of Conduct, vehicle walkthrough and drive test are satisfactorily completed, the employee is deemed eligible to drive the Model S prototype fleet.

Autopilot Training

In addition to the general prototype training, anyone approved to drive an Autopilot prototype car must be rigorously trained in the function, failure, and use of the vehicle function.

3. Description of Functional Behavior
    a. The functional behavior of the autopilot prototype is clearly defined: the function is limited to highway use. The function shall only control the vehicle with clearly identified lane markings. If a lane marking is lost the function will immediately notify the driver through a visual and audible chime and the steering control shall command 0 Nm torque. The Autopilot function shall engage in a lane change maneuver if the turn signal is pressed, direction depending on the turn signal. This maneuver shall only be engaged if both lines of the intended lane are clearly identified, etc. The braking and acceleration control during autopilot operation is handled by the Adaptive Cruise Controller and adheres to ISO standards.
    b. The steering gear shall not command more than 4 Nm of torque. The maximum steering rate is 15 Nm/s of torque.
    c. At all times if the driver has hands on the wheel this shall be detected and the autopilot function shall not command torque.

4. Fault Injection Testing
    a. To understand the limitations and the most severe failure modes, fault injection testing is performed. Maximum torque and maximum torque rate (as defined above) are commanded during normal operation and the driver is expected to immediately overcome such a failure and maintain safe operation. In addition,

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maximum braking is commanded (1.0g of deceleration) for the driver to experience and recover. Finally, maximum torque is commanded and the driver must safely cancel operation (by pressing brake pedal or safety stop) and maintain safe operation.

5. Normal Use Operation
    a. To engage the system, the driver must engage ACC using the stalk. This will engage both adaptive cruise control and steering control. If the brake is pressed, both systems will cancel. If the emergency stop is pressed, both systems will cancel. If the driver steers the wheel, the system shall command 0 Nm but remain engaged. To turn the system off the driver shall disengage using the stalk.

6. New Driver Test
    a. Similar to the test described above for general Model S prototype training, an autopilot candidate driver will take a 30 min. drive with an experienced autopilot driver to ensure the safe operation of the vehicle. They must pass this test and if they fail they will not be permitted to drive the vehicle.

7. Identified Drivers
    a. Andrew Gray
        i. Model S training: 11/1/2013
        ii. Autopilot Training: 9/1/2014
    b. Yiqi Gao
        i. Model S training: 7/1/2014
        ii. Autopilot Training: 9/1/2014