Beta Testing and Ethics

Report

Table of Contents

1 Introduction

1.1 Background

Tesla Motors is an automotive company that manufactures and sells electric cars. In 2012, Tesla launched Model S, together with its new Autopilot software. ("About Tesla", 2016) In 2016, a driver of Tesla Model S crashed into a tractor-trailer and died. At the moment of crashing, Model S's Autopilot mode was engaged. ("A Tragic Loss", 2016)

1.2 Ethical Issue

The accident spurs an ethical issue, which is whether it is ethical to conduct product testing (public beta testing) on the consumers, given that the consumers had already paid for the product itself. Also, whether Tesla should be 'beta testing' the Autopilot software if there is a chance the consumer might die.

1.3 Stakeholders

The stakeholders involved are Tesla Motors (who created the Autopilot software which relies on Mobileye's sensor inputs), Mobileye (a company that manufactures the sensors on Tesla car, vital for the Autopilot software), the driver of the car and the regulators, mainly California Department of Motor Vehicles (DMV) and National Highway Traffic Safety Administration (NHTSA).

1.4 Methodology and Scope

The information of this report will be obtained through research based on articles, laws, regulations and professional standards set by the stakeholders and countries involved. The ethical issue will be countered with critical reasoning and thorough analysis from research, given the suggested solutions. The report introduces an ethical issue brought up by a car crash of Tesla's Model S Car which led to the fatality of the driver. The ethical issue will be supported with articles, research and analysis.

2 Discussion

2.1 How is the Issue Handled by Stakeholders

2.1.1 Tesla Motors

Tesla has informed the National Highway Traffic Safety Administration (NHTSA) immediately after the accident. ("A Tragic Loss", 2016) NHTSA will review the Autopilot software that Tesla created, during the crash.

Tesla also posted a blog post “A Tragic Loss” regarding the accident. Tesla claims that beta-testing should still be continued based on the argument under utilitarian and social contract theory(discussed in Section 2.2). The Autopilot software can never be perfected, however, Tesla believes that the software will be able to improve itself and reduce such incidents from happening in future “as more real-world miles accumulate and the software logic accounts from increasingly rare events”("A Tragic Loss", 2016). With this argument, it benefits the greater good of consumers, as Tesla is constantly working on the algorithm in attempting to perfect the software. Thus, Tesla will be able to improve their products and software for all its consumers.

2.1.2 Mobileye

Mobileye’s partnership with Tesla is withdrawn after the incident. Mobileye claims that their sensors are not designed to cover all possible crash situations as Autopilot software is only a driverless system Thus, this implies that the driver is held responsible on the wheel at all times. ("Mobileye Says It and Tesla Are Never Ever Getting Back Together", 2016) Since their partnership is withdrawn, the company would not be further involved in beta-testing.

2.1.3 Regulators

The National Highway Traffic Safety Administration (NHTSA) immediately launched an investigation on this accident and a preliminary report was released on 26 July 2016. NHTSA will conduct preliminary evaluation to determine whether the Autopilot feature worked according to expectations based on the accident. ("A Tragic Loss", 2016)

On 26 July 2006, NHTSA released the preliminary report on the accident. NHTSA claims that they have yet to conclude that there were any defects with the Autopilot software and the investigation will still be continued. Based on social contract theory, NHTSA does not have the rights to reprimand Tesla yet as Tesla still abide the Order to Adopt regulations. Therefore, NHTSA believes that the way Tesla conducts its beta-testing is acceptable. ("Preliminary Report, Highway HWY16FH018", 2016)

2.2 Ethical Theories

The ethical issue can be discussed in terms of the ethical theories, utilitarian, deontology and social contract theory.

2.2.1 Utilitarian

According to act utilitarian, for the greater good of the consumers, Tesla should continue to pursue beta testing on consumers. As it is understandable that with the current testing procedures on dummies, it would not be enough to simulate real life situation. Dummies cannot emulate how a human react to an accident, or how it would abuse the Autopilot feature. Hence, it supports that beta testing should still be executed on consumers, who are both willing and aware of the risk involved, for the greater good for every consumer. It is stated in the article that loyal customers viewed themselves as part of the testing process which contributed to the overall success of Tesla's better innovation hence, it is acceptable for Tesla to conduct testing. (Kitroeff, N. & Masunaga, S., 2016).

However, some believe that beta testing is morally impermissible as it is inhumane to conduct such an act if it compromises the driver's safety during the testing itself. Automotive industry analyst John McElroy said that "Beta testing with consumers is a very bad idea when it comes to anything related to automotive safety." (Solon, O., 2016)

Nevertheless, car accidents, such as the accident mentioned, can occur to anybody who are not vigilant drivers on the road. The Autopilot feature is used to assist the driver and as stated in the standard agreement, the responsibility still lies on the driver in maintaining control of the car even though Autopilot is activated. It was never meant to function as the replacement of driver behind the wheel.

Moreover, it is least likely that the driver died due to the Autopilot feature as Tesla Model S cars are designed to conduct frequent checks, and if the driver's hands are not on the wheel, the car will automatically slow down. ("A Tragic Loss", 2016) This shows that, to a certain extent, these cars are in fact safer than the traditional cars. Also, it is revealed that by activating the Autopilot feature, overall average of miles travelled per death is 130 million miles from the initial 100 miles travelled. (Morris, D. Z. 2016)

Other than that, drivers of Model S are aware that the Autopilot feature is still in the testing period thus, knowing that it is still not perfect. They also should not overly dependent on the feature.

Therefore, it is ethical to conduct beta-testing for the greatest good of the consumers as Tesla would be able to innovate the cars for them.

2.2.2 Deontology

Based on rule deontology, the practice of conducting beta testing on consumers is immoral because all individual should never be treated as a mean to an end. Tesla uses consumers to achieve cost efficient beta testing. However, as it is previously done using dummies and in simulated and controlled environment, by conducting beta testing on consumers may put them in danger. Tesla exploit customers' trust in the brand and used them as an experimental mechanism, making them a mean to Tesla's end. Since such practice is still new to the market, consumers may be ignorance about the kind of danger that they could be exposed when Autopilot feature failed to work especially in emergency. But as an automotive firm, Tesla should be have known that traffic accident or even death is a possibility for their customers as the Autopilot feature is not perfect. Possessing such important information and choosing to hide it from the public (if public would to be educated and told that they could have lose their lives, they would not have agreed to testing the product). It puts consumers in a less favourable condition. Hence, it is morally unacceptable for Tesla to conduct beta testing on consumers.

Moreover, it is Tesla's duty as a manufacturer to produce and sell products that have passed all stages of test and would not in any time of use pose any danger to users. It is understood that automatic braking system is not a part of Autopilot software but yet,

minimal testing was implemented and emphasized resulting in the car accident of Joshua Brown. (Pandey, A., 2016) Tesla misled consumers by advertising that only the Autopilot software was at testing stage, and consumers would only expect that the software would be imperfect. According to US Consumer Protection Act under Product Liability, Tesla would be held liable if the defective product causes injury and is unreasonably dangerous regardless of fault. (Study.com, 2016) Hence, such practices of beta testing is further supported by act deontology to be immoral.

2.2.3 Social Contract Theory

From the perspective of the Social Contract Theory, the contractual agreement between individuals or organisation is the basis of a moral system. For the case of this accident, the driver had to agree to Tesla Motor's standard agreement in order to use the Autopilot feature, hence it is his or her responsibility to monitor the road's condition at all times, and should take over during emergency situations.

Tesla Motor's blog post, "A Tragic Loss" stated that the Autopilot and the driver did not notice "the white side of the tractor trailer against a brightly lit sky" ("A Tragic Loss", 2016), hence the brake was not applied. Despite the fact that the sensor might have not detected the presence of the tractor, it is ultimately the duty of the driver to monitor the condition of the road at all time as stated in the User Standard Agreement.

Both Tesla Motors and California Department of Motor Vehicles agreed that Tesla's Autopilot feature is a Level 2 Technology (California DMV Supports Tesla Autopilot While Finalizing Autonomous Vehicle Rules, 2015), which means that it will only help drivers make better decision. This means that any accident that happens on the road should be the driver's responsibility and the driver should always be vigilant on the road at all times.

As mentioned before, the Autopilot software will automatically slow the vehicle down if it detects that the driver's hands are not on the steering wheel. The fact that the car is travelling at 74 miles ("Preliminary Report, Highway HWY16FH018", 2016) at the time of the crash means that the driver had his hands on the wheel the whole time before the crash since the Autopilot software did not slow down the car.

Therefore, it is ethical to conduct beta-testing for the innovation of the car because despite any situation on the road, the driver is responsible over the wheel. The Autopilot software only assists the driver, gives warning about a possible collision and suggest drivers better decisions. The causation of the crash seems more likely due to the carelessness of the driver rather than the beta-testing of the Autopilot software.

2.3 Law, Regulations and Professional Standards

2.3.1 Tesla's Standard Agreement

Autopilot Tech Package installation is optional and that if consumers opt-in to purchase and use the Autopilot feature to aid in driving, they would have to agree to the conditions listed in the standard agreement. As indicated, drivers are to oversee all situations on the road and during emergency situations where the car and the Autopilot software failed to work, the driver should be responsible to take over the wheel at all times. ("Is Tesla Responsible for the Deadly Crash On Auto-Pilot? Maybe.", 2016)

2.3.2 2016 Tesla Model S - Owner's Manual

Refer to Appendix A for the owner's manual on the Autopilot software and safety measures it put in place.

One of the safety measures implemented accompanying Autopilot feature to work is for drivers' hands to be on the steering wheel. Checks would be conducted at a predefined interval of 10 seconds or when the car is approaching a bend or is travelling at high speed. If sensor cannot detect the presence of drivers' hands on the steering wheels, the frequency detector would increase frequency wave length until the hands are detected. Unless after several failed attempts in detection, the car would be forced to slowed down and ultimately come to a stop. (Model S Owner's Manual, 2016)

Secondly, collision avoidance system features consist of Autopilot Forward Collision Warning, which assist drivers when dealing with possible frontal collision. The warning system will be sounded if there is a possibility that front collision would happened. However, the manual states that the system might be inaccurate, thus, missing warnings or provide incorrect warnings. (Model S Owner's Manual, 2016) With this, the driver

should always keep their eyes on the road while driving and not to overly rely on the warnings given by the system as it may cause injury and even to the extent of death. This Autopilot software is not meant to control the car's movement but only to assist the driver's decisions on the road. It is also designed to ensure the safety of the driver by providing warnings when such dangerous situations mentioned before occurs.

2.3.3 California's Department of Motor Vehicles (DMV)

Refer to Appendix B on information about autonomous vehicles and its requirements for a manufacturer's testing permit.

In the Order to Adopt regulations by the California DMV, Title 13, Division 1, Chapter 1, under Section 227.02 Definitions, part (b), it states that the "Autonomous vehicle" is classified as any vehicle that is equipped with technology that has the capability of manoeuvring the vehicle without physical control of a driver, even if the technology is or is not engaged, and it excludes vehicles that are equipped with a few systems that consists of features that enhances safety for the driver or provide driver's assistance, but at the same time, not capable of manoeuvring the vehicle without the control of a natural person. (Order to Adopt, 2016) Since Model S was designed with a few safety features in its Autopilot software and also acts as a driver's assistance feature, at the same time the car is not able to manoeuvre on its own without the driver, Model S does not fall under the category of "autonomous vehicle".

The California Department of Motor Vehicles (DMV) has approved Tesla Motors' permit, as of 29 August 2016, to conduct testing on public roads as they have met the requirements of its laws and regulations. ("Testing of Autonomous Vehicles", 2016) Tesla's Autopilot software is not considered as an autonomous technology because it does not have the ability to drive the car on its own, and needs a driver to operate the car, according to the DMV. (Order to Adopt, 2016) Thus, the driver should be taking responsibility on the road, rather than the Autopilot software.

2.4 Suggested Improvements

One of the improvements that could be done by Tesla is that there is a need to clarify the conceptual muddle of the use and objective of the Autopilot software. Although the

California DMV states that Tesla's Autopilot is Level 2 autonomous technology, the introduction of some features, as well as the name 'Autopilot', may mislead users to recognize Autopilot as level 3 technology, so that they may rely too much on the system when driving. This problem is often described as the "Handoff Problem" (*Google Self-Driving Car Project Monthly Report, 2015)*, when the human must regain manual control in a short period of time to avert disaster.

People often get too comfortable after seeing the Autopilot software is working smoothly, and the impression that the Autopilot software is taking full control will start to cause the driver to divert his/her attention to other things such as checking their mail on the phone. Another improvement would be that Tesla should state more clearly about to what extent the Autopilot software can help drivers understand fully on the use of the software. This will be a part of the education campaign conducted by Tesla to give a better insight and educate their consumers on this new technology. Therefore, fulfilling their responsibility as a automobile company. This can be done by providing video demonstrations of each feature that the Autopilot software offers.

3 Conclusion

3.1 Implications of Ethical Issue

Ideally, a product should be tested extensively and perfectly before it is launched to the public. However, in reality, it is not financially feasible for a company to fully test a product till perfection as it could take a lot of manpower, time and resources to do so. Companies can only test the product adequately, and possibly continue improving and learning on the way.

For the context of autonomous vehicle, these vehicle can always be improved but not perfected. Tesla should continue to conduct beta-testing to improve its algorithm as it is extremely difficult to perfect it as situations on the road changes overtime. Moreover, by beta-testing, the car would be exposed to the different kinds of real-life situations.

Beta-testing on sold product should be conducted based on utilitarian and social contract theory perspectives.

3.2 Key Takeaways

There is no clear boundary of who is responsible for the behaviour of the Autopilot feature. Every stakeholders has a role to play.

The design of algorithm can never be perfected because of the unknown scenarios happening on the road.

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Appendix A

Selected pages from the Model S Owner's Manual that provides information about driver's assistance and user warnings. (Model S Owner's Manual, 2016)

Driver Assistance Features

These safety features are available on all Model S vehicles equipped with Driver Assistance components:

- Lane Assist (see Lane Assist on page 83).
- Collision Avoidance Assist (see Collision Avoidance Assist on page 85).
- Speed Assist (see Speed Assist on page 88).

These convenience features, designed to reduce driver workload, are available only if Model S is equipped with the optional Autopilot Tech Package:

- Traffic-Aware Cruise Control (see Traffic-Aware Cruise Control on page 68).
- Autosteer (see Autosteer on page 74).
- Auto Lane Change (see Auto Lane Change on page 77).
- Autopark (see Autopark on page 79).
- Auto High Beam (see High Beam Headlights on page 51).

You can enable/disable driver assistance features and in some cases, control how they work. To access settings for Driver Assistance features, touch Controls > Settings > Driver Assistance.

Limitations

Many factors can impact the performance of Driver Assistance components, causing them to be unable to function as intended. These include (but are not limited to):

- Poor visibility (due to heavy rain, snow, fog, etc.).
- Bright light (oncoming headlights or direct sunlight).
- Damage or obstructions caused by mud, ice, snow, etc.
- Interference or obstruction by object(s) mounted onto Model S (such as a bike rack or a sticker).
- Narrow or winding roads.
- A damaged or misaligned bumper.
- Interference from other equipment that generates ultrasonic waves.
- Extremely hot or cold temperatures.

Warning: The list above does not represent an exhaustive list of situations that may interfere with proper operation of Driver Assistance components. Never depend on these components to keep you safe. It is the driver's responsibility to stay alert, drive safely, and be in control of the vehicle at all times.

Caution: If a windshield replacement is needed on a Model S equipped with the forward looking camera, you must take your vehicle to Tesla Service. This will ensure appropriate handling and mounting of the camera. Failure to do so can cause one or more Driver Assistance features to malfunction.

Cleaning Driver Assistance Components

To ensure the various Driver Assistance components can provide information that is as accurate as possible, keep them clean and free of obstructions. Occasionally remove any buildup of dirt by wiping with a soft cloth dampened with warm water.

Caution: Do not use chemical-based or abrasive cleaners. Doing so can damage surfaces.

Caution: Avoid using a high-pressure power washer.

Caution: Do not clean an ultrasonic sensor with a sharp or abrasive object that can scratch or damage its surface.

Note: Autosteer is a BETA feature in Release 7.1.

If Model S is equipped with Driver Assistance components (see About Driver Assistance on page 65), and you have purchased the optional Autopilot Tech Package, you can use Autosteer to manage steering and speed under certain circumstances. Autosteer builds upon Traffic-Aware Cruise Control, intelligently keeping Model S in its driving lane when cruising at a set speed. Using the forward looking camera, the radar sensor, and the ultrasonic sensors, Autosteer detects lane markings and the presence of vehicles and objects, steering Model S based on the lane markings and the vehicle directly in front of you.

Warning: Autosteer is a hands-on feature. You must keep your hands on the steering wheel at all times.

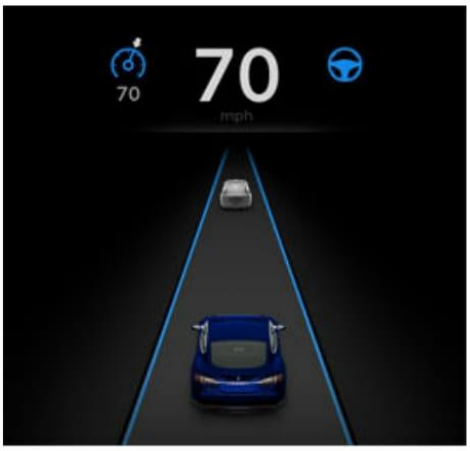
Warning: Autosteer is intended for use only on highways and limited-access roads with a fully attentive driver. When using Autosteer, hold the steering wheel and be mindful of road conditions and surrounding traffic. Do not use Autosteer on city streets or in areas where bicyclists or pedestrians may be present. Never depend on Autosteer to determine an appropriate driving path. Always be prepared to take immediate action. Failure to follow these instructions could cause serious property damage, injury or death.

Operating Autosteer

Before you can operate Autosteer, you must enable it by touching Controls > Settings > Driver Assistance > Autosteer > Enable.

To indicate that Autosteer is available (but not actively steering Model S), the instrument panel displays a gray Autosteer icon on the right side of the driving speed as shown here:

To initiate Autosteer, pull the cruise control lever toward you twice in quick succession. Autosteer briefly displays a message on the instrument panel reminding you to pay attention to the road and be ready to take over at any time. To indicate that Autosteer is now actively steering Model S, the instrument panel displays the Autosteer icon in blue. When Autosteer is able to detect lane markings, it also displays the driving lane in blue:



Note: To initiate Autosteer, you must be driving at least 18 mph (30 km/h) on a roadway with visible lane markings. If a vehicle is detected ahead of you, you can initiate Autosteer at any speed, even when stationary.

Note: In most cases, Autosteer attempts to center Model S in the driving lane. However, if the sensors detect the presence an obstacle (such as a vehicle or guard rail), Autosteer may steer Model S in a driving path that is offset from the center of the lane.

Note: In situations where you attempt to engage Autosteer but you are not driving within the required driving speed for Autosteer to operate, or Autosteer is not receiving adequate data from the camera or sensors, a message displays on the instrument panel indicating that Autosteer is temporarily unavailable.

Restricted Roads

Autosteer is intended for use on freeways and highways where access is limited by entry and exit ramps. When using Autosteer on residential roads, a road without a center divider, or a road where access is not limited, Autosteer limits the driving speed. The maximum driving speed is calculated based on the detected speed limit plus 5 mph (10 km/h). In situations where the speed limit can not be detected, speed is limited to 45 mph (70 km/h). When Autosteer is engaged on a restricted road, it reduces the speed to be within these limits, even if the set cruising speed is higher. The instrument panel displays a message indicating that you are driving on a restricted road. You can manually accelerate to exceed the limited speed, but when you release the accelerator pedal, Autosteer slows Model S to the limited speed. When you leave the restricted road, or disengage Autosteer by using the steering wheel, Model S resumes cruising at the set speed.

Hold Steering Wheel

Autosteer uses data from the camera, sensors, and GPS system to determine where to drive. It also requires you to hold the steering wheel. When entering a curve or driving at a high speed, if Autosteer does not detect your hands on the steering wheel, it displays the following message on the instrument panel and eventually sounds a chime:

When you see this message, you may need to tighten your grip on the steering wheel. When your hands are detected, Autosteer resumes normal operation.

Note: Be careful not to apply any steering. Doing so cancels Autosteer.

If Autosteer does not detect your hands on the steering wheel, the Hold Steering Wheel request escalates by sounding two additional chimes. The chimes increase in frequency until Autosteer detects your hands. If no action is taken, Autosteer begins to decelerate Model S and displays the following message on the instrument panel:

Autosteer will eventually decelerate Model S to a full stop and then turn on the hazard warning flashers.

Take Over Immediately

In situations where Autosteer is unable to steer Model S, Autosteer sounds a warning chime and displays the following message on the instrument panel:

When you see this message, TAKE OVER STEERING IMMEDIATELY.

Canceling Autosteer

Autosteer cancels when:

- You start steering manually.
- You press the brake pedal.
- You push the cruise control lever away from you.
- You unbuckle the driver's seat belt.
- The maximum speed that Autosteer supports (90 mph/150 km/h) is exceeded.
- You shift out of the Drive gear.
- An Automatic Emergency Braking event occurs (see Collision Avoidance Assist on page 85).

When Autosteer cancels, the Autosteer icon is gray to indicate that Autosteer is no longer active.

Note: If Autosteer cancels because you started steering manually, Traffic-Aware Cruise Control remains active. Disengage Traffic-Aware Cruise Control as you normally would, by pressing the brake or briefly pushing the cruise control lever away from you.

To disable Autosteer so it is no longer available, touch Controls > Settings > Driver Assistance > Autosteer > Cancel.

Limitations

Autosteer is particularly unlikely to operate as intended in the following situations:

- Autosteer is unable to accurately determine lane markings due to poor visibility (heavy rain, snow, fog, etc.), or an obstructed, covered, or damaged camera or sensor.
- When driving on hills.
- The road has sharp curves or is excessively rough.
- Bright light (such as direct sunlight) is interfering with the camera's view.
- The sensors are affected by other electrical equipment or devices that generate ultrasonic waves.

⚠ Warning: Many unforeseen circumstances can impair the operation of Autosteer. Always keep this in mind and remember that as a result, Autosteer may not steer Model S appropriately. Always drive attentively and be prepared to take immediate action.

If Model S is equipped with Driver Assistance components (see About Driver Assistance on page 65), the following collision avoidance features are designed to increase the safety of you and your passengers:

- Forward Collision Warning provides visual and audible warnings in situations where there is a high risk of a frontal collision (see Forward Collision Warning on page 85).
- Automatic Emergency Braking automatically applies braking to reduce the impact of a frontal collision (see Automatic Emergency Braking on page 86).

⚠ Warning: Forward Collision Warning is for guidance purposes only and is not a substitute for attentive driving and sound judgment. Keep your eyes on the road when driving and never depend on Forward Collision Warning to warn you of a potential collision. Several factors can reduce or impair performance, causing either unnecessary, invalid, inaccurate, or missed warnings. Depending on Forward Collision Warning to warn you of a potential collision can result in serious injury or death.

⚠ Warning: Automatic Emergency Braking is not designed to prevent a collision. At best, it can minimize the impact of a frontal collision by attempting to reduce your driving speed. Depending on Automatic Emergency Braking to avoid a collision can result in serious injury or death.

Forward Collision Warning

The forward looking camera and the radar sensor monitor the area in front of Model S for the presence of an object such as a vehicle, bicycle or pedestrian. If a collision is considered likely unless you take immediate corrective action, Forward Collision Warning is designed to sound a chime and highlight the vehicle in front of you in red on the instrument panel:

Warnings cancel automatically when the risk of a collision has been reduced (for example, you have decelerated or stopped Model S, or a vehicle in front has moved out of your driving path).

If immediate action is not taken when Model S issues a Forward Collision Warning, a collision is considered imminent and Automatic Emergency Braking (if enabled) automatically applies the brakes (see Automatic Emergency Braking on page 86).

By default, Forward Collision Warning is turned on. To turn it off or adjust its sensitivity, touch Controls > Settings > Driver Assistance > Forward Collision Warning. Instead of the default warning level of Medium, you can turn the warning Off, or you can choose to be warned Late or Early.

Note: Your chosen setting for Forward Collision Warning is retained until you manually change it. It is also saved in your driver profile.

⚠ Warning: The cameras and sensors associated with Forward Collision Warning are designed to monitor an approximate area of up to 525 feet (160 meters) in your driving path. The area being monitored by Forward Collision Warning can be adversely affected by road and weather conditions. Use appropriate caution when driving.

⚠ Warning: Forward Collision Warning is designed only to provide visual and audible alerts. It does not attempt to apply the brakes or decelerate Model S. When seeing and/or hearing a warning, it is the driver's responsibility to take corrective action immediately.

⚠ Warning: Forward Collision Warning may provide a warning in situations where the likelihood of collision may not exist. Stay

alert and always pay attention to the area in front of Model S so you can anticipate whether any action is required.

- Warning: Forward Collision Warning does not operate when Model S is traveling less than 4 mph (7 km/h).
- Warning: Forward Collision Warning does not provide a warning when the driver is already applying the brake.

Automatic Emergency Braking

The forward looking camera and the radar sensor are designed to determine the distance from any object (vehicle, motorcycle, bicycle, or pedestrian) traveling in front of Model S. When a frontal collision is considered unavoidable, Automatic Emergency Braking is designed to automatically apply the brakes to reduce the severity of the impact.

When Automatic Emergency Braking applies the brakes, the instrument panel displays a visual warning and you'll hear a chime. You may also notice abrupt downward movement of the brake pedal. The brake lights turn on to alert other road users that you are slowing down.

When Automatic Emergency Braking has reduced the driving speed by 25 mph (40 km/h), the brakes are released. For example, if Automatic Emergency Braking applies braking when driving at 56 mph (90 km/h), it releases the brakes when the speed has been reduced to 31 mph (50 km/h).

Automatic Emergency Braking operates only when driving between 5 mph (8 km/h) and 85 mph (140 km/h).

Automatic Emergency Braking does not apply the brakes, or stops applying the brakes, in situations where you are taking action to avoid a potential collision. For example:

- You turn the steering wheel sharply.
- You press the accelerator pedal.
- You press and release the brake pedal.
- A vehicle, motorcycle, bicycle, or pedestrian, is no longer detected ahead.

Automatic Emergency Braking is always enabled when you start Model S. To disable it for your current drive, touch Controls > Settings > Driver Assistance > Automatic Emergency Braking > Disable.

- Warning: It is strongly recommended that you do not disable Automatic Emergency Braking. If you disable it, Model S does not automatically apply the brakes in situations where a collision is considered likely.
- Warning: Automatic Emergency Braking is designed to reduce the severity of an impact. It is not designed to avoid a collision.
- Warning: Several factors can affect the performance of Automatic Emergency Braking, causing either no braking or inappropriate or untimely braking. It is the driver's responsibility to drive safely and remain in control of the vehicle at all times. Never depend on Automatic Emergency Braking to avoid or reduce the impact of a collision.
- Warning: Automatic Emergency Braking is designed to reduce the impact of frontal collisions only and does not function when Model S is in reverse.
- Warning: Automatic Emergency Braking is not a substitute for maintaining a safe traveling distance between you and the vehicle in front of you.
- Warning: The brake pedal moves downward abruptly during automatic braking events. Always ensure that the brake pedal can move freely. Do not place material on top of the Tesla-supplied driver's floor mat (including an additional mat) and always ensure that the driver's floor mat is properly secured. Failure to do so can impede the ability of the brake pedal to move freely.

Note: For advance notice of an Automatic Emergency Braking event, turn on Forward Collision Warning (see Forward Collision Warning on page 85). When turned on, you hear a chime and see a collision warning in the center of the instrument panel if a collision is considered likely. Then, if you do not take immediate corrective action, a collision is considered imminent and Automatic Emergency Braking applies braking to reduce driving speed. If enabled, Automatic Emergency Braking applies braking when a collision is considered inevitable, even if Forward Collision Warning is turned off.

Limitations and Inaccuracies

Collision Avoidance features cannot always detect vehicles, bikes, or pedestrians, and you may experience unnecessary, inaccurate, invalid, or missed warnings for many reasons, particularly if:

- The road has sharp curves.
- Visibility is poor (due to heavy rain, snow, fog, etc.).
- Bright light (oncoming headlights or direct sunlight) is interfering with the camera's view.
- The radar sensor in the center of the front grill is obstructed (dirty, covered, etc.).
- The windshield area in the camera's field of view is obstructed (fogged over, dirty, covered by a sticker, etc.).

Warning: The limitations described above do not represent an exhaustive list of situations that may interfere with proper operation of Collision Avoidance Assist features. These features may fail to provide their intended function for many other reasons. It is the driver's responsibility to avoid collisions by staying alert and paying attention to the area beside Model S so you can anticipate the need to take corrective action as early as possible.

Caution: If a fault occurs with a Collision Avoidance Assist feature, Model S displays an alert. Contact Tesla Service.

Appendix B

Pages 1 - 2 of the Order to Adopt regulations by California Department of Motor Vehicles. (*Order to Adopt*, 2016)

Order to Adopt
Title 13, Division 1, Chapter 1

Article 3.7 – Autonomous Vehicles

§ 227.00. Purpose.

(a) The regulations in this article implement, interpret and make specific Division 16.6 (commencing with section 38750) of the Vehicle Code, originally added by Statutes of 2012, Chapter 570 (SB 1298), providing for the regulation of autonomous vehicles operated on public roads in California.

(b) A motor vehicle shall not be operated in autonomous mode on public roads in California except as permitted under Vehicle Code section 38750 and the regulations in this article.

NOTE: Authority cited: Sections 1651 and 38750, Vehicle Code. Reference: Section 38750, Vehicle Code.

§ 227.02. Definitions.

As used in this article the following definitions apply:

(a) "Autonomous mode" means an autonomous vehicle, as defined by this article, that is operated or driven without active physical control by a natural person sitting in the vehicle's driver's seat. An autonomous vehicle is operating or driving in autonomous mode when it is operated or driven with the autonomous technology engaged.

(b) "Autonomous vehicle" means any vehicle equipped with technology that has the capability of operating or driving the vehicle without the active physical control or monitoring of a natural person, whether or not the technology is engaged, excluding vehicles equipped with one or more systems that enhance safety or provide driver assistance but are not capable of driving or operating the vehicle without the active physical control or monitoring of a natural person.

(c) "Autonomous vehicle test driver" means a natural person seated in the driver's seat of an autonomous vehicle, whether the vehicle is in autonomous mode or conventional mode, who possesses the proper class of license for type of vehicle being driven or operated, and is capable of taking over active physical control of the vehicle at any time.

(d) "Conventional mode" means the vehicle is under the active physical control of a natural person sitting in the driver's seat operating or driving the vehicle with the autonomous technology disengaged.

(e) "Designee" means the natural person identified by the manufacturer to the department as a person authorized by the manufacturer to drive or operate the manufacturer's autonomous vehicles on public roads.

(f) "Manufacturer" means a manufacturer of autonomous technology as defined in Vehicle Code section 38750 (a)(5) and includes a vehicle manufacturer as defined in Vehicle Code section 672 that produces an autonomous vehicle from raw materials or new basic components; and, a person as defined in Vehicle Code section 470 who modifies any vehicle by installing autonomous technology.

(g) "Public road" means "highway" as defined in Vehicle Code section 360, "offstreet public parking facility" as defined in Vehicle Code section 4000, and "street" as defined in Vehicle Code section 590.

NOTE: Authority cited: Sections 1651 and 38750, Vehicle Code. Reference: Sections 360, 470, 590, 672, 4000, and 38750, Vehicle Code.

§ 227.04. Requirements for a Manufacturer's Testing Permit.

A manufacturer may conduct testing of autonomous vehicles on public roads in California if all of the following requirements are met:

(a) The manufacturer is conducting the testing.

(b) The vehicle is operated by an autonomous vehicle test driver who is an employee, contractor, or designee of the manufacturer, who has been certified by the manufacturer to the department as competent to operate the vehicle and has been authorized by the manufacturer to operate the vehicle.

(c) The manufacturer has in place and has provided the department with evidence of the manufacturer's ability to respond to a judgment or judgments for damages for personal injury, death, or property damage arising from the operation of autonomous vehicles on public roads in the amount of five million dollars ($5,000,000), in the form of: an instrument of insurance issued by an insurer admitted to issue insurance in California; a surety bond issued by an admitted surety insurer or an eligible surplus lines insurer, and not a deposit in lieu of bond; or a certificate of self-insurance.

(d) The manufacturer has applied for and the department has issued to the manufacturer a Manufacturer's Testing Permit to conduct autonomous vehicle testing on public roads in California.

NOTE: Authority cited: Sections 1651 and 38750, Vehicle Code. Reference: Section 38750, Vehicle Code.

§ 227.06. Evidence of Financial Responsibility.

A manufacturer's obligation to provide evidence of an ability to respond to damages under Vehicle Code section 38750 is in addition to any other insurance obligation required by law.

NOTE: Authority cited: Sections 1651 and 38750, Vehicle Code. Reference: Section 38750, Vehicle Code.