Additional Information Regarding EA22002

Investigation: EA22002 **Date: 4/25/2024**

EA22002 (upgraded from PE21020) was opened to conduct extensive crash analysis, human factors analysis, and vehicle evaluations, and to assess vehicle control authority and driver engagement technologies. After discussions with NHTSA, Tesla filed a Defect Information Report (Recall 23V838) on December 12, 2023, applicable to all Tesla models produced and equipped with any version of its Autopilot[1] system, which Tesla described as an SAE Level 2 (L2) Advanced Driver Assistance System (ADAS). Tesla concluded in its 23V838 filing that, in certain circumstances, Autopilot's system controls may be insufficient for a driver assistance system that requires constant supervision by a human driver. Tesla filed Recall 23V838 to address concerns regarding the Autopilot system investigated in EA22002. These insufficient controls can lead to foreseeable driver disengagement while driving and avoidable crashes.

ODI and other NHTSA subject matter experts performed substantial work in EA22002, including:

- Sent multiple Information Request (IR) letters to Tesla and to L2 peer manufacturers to collect the following information concerning L2 vehicle technology:
    - Production and field data
    - Engineering specifics concerning control authority, driver engagement, and operational design domain
    - Communications to customers
    - Methods for detecting first responder scenes
    - System changes, development, and validation/verification approaches
    - Company approaches to crash evaluation
    - Assessment of L2 system involvement with reported crashes

- Conducted an in-depth crash analysis to characterize crash circumstances

- Convened multiple technical meetings with Tesla to review specific crashes and system change releases

- Performed hands-on vehicle evaluations to assess vehicle human-machine interfaces and evaluated human factors consideration in design and controls

- Examined Tesla's changes to Autopilot

- Compared Autopilot to peer L2 systems in-field by:
    - Control authority
    - Operational Design Domain (ODD)
    - Object and Event Detection and Response (OEDR)
    - Driver engagement systems
    - Ease of engagement

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[1] Autopilot refers to simultaneous engagement of TACC and Autosteer.

- Naming convention

Crash Analysis

Throughout the PE21020 and EA22002 investigations, ODI observed a trend of avoidable crashes involving hazards that would have been visible to an attentive driver. Before August 2023, ODI reviewed 956 total crashes where Autopilot was initially alleged to have been in use at the time of, or leading up to, those crashes. ODI's crash review involved two separate actions:

1. A detailed analysis covered 446 crashes occurring from early 2018 through August 2022 that relied on in-depth assessments of video from the subject vehicle onboard cameras, event data recorders (EDR), data logs, and other information; and

2. A supplemental analysis, which focused on 510 Tesla incidents gathered through the Standing General Order (SGO) process from August 2022 to the end of August 2023. ODI's analysis of these crashes relied primarily on Tesla's narratives and videos and data logs obtained from Tesla for a portion of the 510 crashes. When supporting videos and data logs were unavailable, ODI used Tesla's source material inventory as stated in the SGO narrative (such as full, partial or no video, logs, etc.) to assign a confidence level to its assessment. The supplemental analysis drew similar conclusions to those of the detailed analysis.

ODI continued to observe and follow up on SGO-reported crashes after August 2023 up to the recall filing and generally observed conditions similar to those identified in the analyses.

Condition	Detailed Crash Analysis (Jan 2018 - Aug 2022)				Supplemental Crash Analysis (Aug 2022 - Aug 2023)		Total	
	Crashes	Fatal Crashes	Casualties		Crashes	Fatal Crashes	Crashes	Fatal Crashes
			Deaths	Injuries				
Frontal Plane Struck Vehicle / Object / Person in travel path	143	9	10	49	68	4	211	13
Yaw / Spin / Understeer (low traction environment)	53	--	--	3	92	--	145	--
Inadvertent Steering Override (Cancel AS, keep TACC)	55	--	--	1	56	--	111	--
FSD-Beta Crash	15	--	--	2	60	1	75	1
Analysis-Exclude-Indeterminate	66	3	3	19	65	1	131	4
Analysis-Exclude- Other Vehicle Fault	83	--	--	19	82	4	165	4
Analysis-Exclude-Unrelated to- / No full AP engagement	31	3	5	8	50	4	81	7
Other	--	--	--	--	37	--	37	--
Total	446	15	18	101	510	14	956	29

Table 1: Detail and Supplemental Analysis Crash Counts, Conducted by NHTSA

Generally, the crashes that were the subject of ODI's analysis fell into one of three categories:

<u>Frontal Plane</u>:
211 crashes were identified in which the frontal plane of the Tesla struck a vehicle or obstacle in its path. This crash type includes the first responder crashes that prompted the original investigation. When a driver is disengaged with the Tesla vehicle operating in Autopilot and the vehicle encounters a circumstance outside of Autopilot's object or event detection response capabilities (e.g., obstacle detection and/or forward path planning), crash outcomes are often severe because neither the system nor the driver reacts appropriately, resulting in high-speed differential and high energy crash outcomes. The 211 crashes considered as part of this analysis resulted in 13 fatal crashes leading to 14 deaths and 49 injuries.

ODI's analysis of crash data indicates that, prior to Recall 23V838, Autopilot's design was not sufficient to maintain drivers' engagement. 109 of the 143 crashes from the detailed analysis included data sufficient to measure the time between impact and the time a hazard would have come into the visual field of an engaged driver. In more than half (59) of these crashes, the hazard was visible five or more seconds prior to the impact, with a subset of 19 exhibiting a hazard visible for over 10 seconds prior to the collision. For events unfolding faster, such as those where the hazard may have first been seen less than two seconds prior to the crash, an attentive driver's timely actions could have mitigated the severity of a crash even if the driver may not have been able to avoid the crash altogether.

Hazard Visible Time Bin	Total	Percent
≥ 10 sec	19	17%
5 – 10 sec	40	37%
2 – 5 sec	42	39%
< 2 sec	8	7%
Total	109	100%

Table 2: Hazard Visible Time vs Roadway- Detailed Analysis, Conducted by NHTSA

For 135 incidents, the driver response to a hazard prior to impact was identified through a review of the EDR and vehicle data logs. Drivers either did not brake or braked less than one second prior to the crash in 82 percent of the incidents, and either did not steer or steered less than one second prior to impact in 78 percent of the incidents.

For example, ODI reviewed a fatal crash that occurred in July 2023 in Warrenton, Virginia involving a 2023 Model Y. The Tesla was traveling at highway speed on a rural highway with cross traffic and struck the side of a turning tractor-trailer crossing its path. ODI conducted a post-crash inspection of the vehicle and crash scene. Based on available information, the tractor-trailer would have been visible to an attentive driver with sufficient time to avoid the crash.

Another crash occurred in March 2023 in North Carolina and involved a 2022 Model Y. The vehicle was traveling at highway speed when it struck a minor pedestrian exiting a school bus. The pedestrian was evacuated by air to a hospital for treatment of serious injuries. Based on publicly available information, both the bus and the pedestrian would have been visible to an attentive driver and allowed the driver to avoid or minimize the severity of this crash.

This analysis, conducted before Recall 23V838, indicated that drivers involved in the crashes were not sufficiently engaged in the driving task and that the warnings provided by Autopilot when Autosteer was engaged did not adequately ensure that drivers maintained their attention on the driving task. The drivers were involved in crashes while using Autopilot despite fulfilling Tesla's pre-recall driver engagement monitoring criteria. Crashes with no or late evasive action attempted by the driver were found across all Tesla hardware versions and crash circumstances.

Yaw Loss of Control:

53 crashes were identified where Autosteer was in use in a lower traction environment, such as on wet roads, where the vehicle lost traction and subsequently directional control, leading to a crash where the first harmful event was road departure. In these low traction incidents, generally, the vehicle almost immediately departs the lane after losing lane centering that often results in an impact with a roadway barrier or other object.

Inadvertent Override:

55 crashes were identified where Autopilot was in use, but it appeared that the driver may have inadvertently or unknowingly deactivated Autosteer while TACC remained engaged. This happened either through steering inputs that exceeded the manual override threshold, resulting in the vehicle drifting out of its lane, or through enough intermittent steering input to change the heading, generally resulting in a single vehicle roadway departure crash as the first harmful event. Crash factors indicate that driver disengagement, coupled with the Autopilot system design, is the key contributor to these crashes. Almost all the incidents (43) were involved in a crash less than 5 seconds after Autopilot was overridden by a steering torque and the vehicle lost lane centering and departed the travel lane.

Crash Rate and Telemetry

Gaps in Tesla's telematic data create uncertainty regarding the actual rate at which vehicles operating with Autopilot engaged are involved in crashes. Tesla is not aware of every crash involving Autopilot even for severe crashes because of gaps in telematic reporting. Tesla receives telematic data from its vehicles, when appropriate cellular connectivity exists and the antenna is not damaged during a crash, that support both crash notification and aggregation of fleet vehicle mileage. Tesla largely receives data for crashes only with pyrotechnic deployment,[2] which are a minority of police reported crashes.[3] A review of NHTSA's 2021 FARS and Crash Report Sampling System (CRSS) finds that only 18 percent of police-reported crashes include airbag deployments.

Tesla's telematics also do not fully account for the difference in crash report trends with other L2 systems. A majority of peer L2 companies queried by ODI during this investigation rely mainly on traditional reporting systems (where customers file claims after the crash and the company follows up with traditional information collection and/or vehicle inspection). NHTSA has a wide variety of ways to receive crash reports and ODI did not rely on a simplistic crash rate comparison between Tesla and its L2 peers based on report counts alone. Rather, ODI also relied on a qualitative review of the crash circumstances as reported by the Tesla systems, including such information as how long

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[2] Pyrotechnic deployment in this case refers to deployment of passive protection systems including air bags, seat belt pre-tensioners, and the pedestrian impact mitigation feature of the vehicle hood.

[3] Tesla's published Autopilot technology and non-Autopilot technology crash rates are also typically expressed in miles driven per pyrotechnic deployment.

the hazard was visible, whether the crash was reasonably avoidable, and vehicle/driver performance.

ODI uses all sources of crash data, including crash telematics data, when identifying crashes that warrant additional follow-up or investigation. ODI's review uncovered crashes for which Autopilot was engaged that Tesla was not notified of via telematics. Prior to the recall, Tesla vehicles with Autopilot engaged had a pattern of frontal plane crashes that would have been avoidable by attentive drivers, which appropriately resulted in a safety defect finding.

Peer Comparison

Data gathered from peer IR letters helped ODI document the state of the L2 market in the United States, as well as each manufacturer's approach to the development, design choices, deployment, and improvement of its systems. A comparison of Tesla's design choices to those of L2 peers identified Tesla as an industry outlier in its approach to L2 technology by mismatching a weak driver engagement system with Autopilot's permissive operating capabilities.

Unlike peer L2 systems tested by ODI, Autopilot presented resistance when drivers attempted to provide manual steering inputs. Attempts by the human driver to adjust steering manually resulted in Autosteer deactivating. This design can discourage drivers' involvement in the driving task. Other systems tested during the PE and EA investigation accommodated drivers' steering by suspending lane centering assistance and then reactivating it without additional action by the driver.

Notably, the term "Autopilot" does not imply an L2 assistance feature, but rather elicits the idea of drivers not being in control. This terminology may lead drivers to believe that the automation has greater capabilities than it does and invite drivers to overly trust the automation. Peer vehicles generally use more conservative terminology like "assist," "sense," or "team" to imply that the driver and automation are intended to work together, with the driver supervising the automation.