



U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

ODI RESUME

Investigation: DP 20-001
Prompted by: Defect Petition
Date Opened: 01/13/2020
Investigator: Ajit Alkondon
Approver: Stephen Ridella
Subject: Sudden Unintended Acceleration

Date Closed: 01/08/2021
Reviewer: Jeff Quandt

MANUFACTURER & PRODUCT INFORMATION

Manufacturer: Tesla, Inc.
Products: MY2012-2020 Tesla Model S, Model X, Model 3 and Model Y
Population: 662,109

Problem Description: The petition alleges that the subject vehicles contain a defect that can cause sudden unintended acceleration, which may result in crash and injury.

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints:	0	0	0
Crashes/Fires:	0	0	0
Injury Incidents:	0	0	0
Fatality Incidents:	0	0	0
Other*:	246	0	0

***Description of Other:** NHTSA complaints cited by the petitioner (232) and 14 additional complaints to NHTSA related to SUA crash allegations that were either not selected by the petitioner or were submitted after the petitioner's most recent submission.

ACTION / SUMMARY INFORMATION

Action: This defect petition has been denied.

Summary:

On December 19, 2019, NHTSA received a petition from Mr. Brian Sparks requesting that the Agency "recall all [Tesla] Model S, Model X, and Model 3 vehicles produced from 2013 to the present" due to sudden unintended acceleration (SUA). In his petition and follow-up submissions, the petitioner identified a total of 232 non-duplicative complaints to NHTSA, including 203 reporting crashes. On January 13, 2020, NHTSA's Office of Defects Investigation (ODI) opened Defect Petition DP20-001 to evaluate the petitioner's request. ODI's evaluation included reviews of all complaints and supporting information referenced by the petitioner, as well as 14 additional complaints to NHTSA related to SUA crash allegations that were either not selected by the petitioner or were submitted after the petitioner's most recent submission. The review also included analyses of available crash data (EDR, Tesla log data, and/or video data) the Agency acquired as part of the evaluation.

After reviewing the available data, ODI has not identified evidence that would support opening a defect investigation into SUA in the subject vehicles. In every instance in which event data was available for review by ODI, the evidence shows that SUA crashes in the complaints cited by the petitioner have been caused by pedal misapplication. There is no evidence of any fault in the accelerator pedal assemblies, motor control systems, or brake systems that has contributed to any of the cited incidents. There is no evidence of a design factor contributing to increased likelihood of pedal misapplication. The theory provided of a potential electronic cause of SUA in the subject vehicles is based upon inaccurate assumptions about system design and log data.

NHTSA is authorized to issue an order requiring notification and remedy of a defect if the Agency's investigation shows a defect in design, construction, or performance of a motor vehicle that presents an unreasonable risk to safety.

49 U.S.C. §§ 30102(a)(9), 30118. Since the information before the Agency is not indicative of a vehicle-based defect, it is unlikely that any investigation opened because of granting this petition would result in an order concerning the notification and remedy of a safety-related defect. Therefore, upon full consideration of the information presented in the petition and the potential risks to safety, the petition is denied. The denial of this petition does not foreclose the Agency from taking further action if warranted or the potential for a future finding that a safety-related defect exists based upon additional information the agency may receive.

The reference numbers for the complaints to NHTSA cited by the petitioner can be found in the petition submission documents in the public file for DP20-001. Those complaints and the 14 complaints ODI added to its evaluation can be viewed at [NHTSA.gov](https://www.nhtsa.gov). The reference numbers for the complaints added by ODI are: 11385350, 11383955, 11383233, 11383180, 11378492, 11378458, 11302076, 11299698, 11290006, 11190595, 11174504, 11115496, 11096644 and 11000097. The attached report, further detailing NHTSA's reasons for denial of the petition, will be published in the Federal Register.

DEPARTMENT OF TRANSPORTATION

National Highway Traffic Safety Administration

[Docket No. NHTSA-2019-0105]

Denial of Motor Vehicle Defect Petition

AGENCY: National Highway Traffic Safety Administration (NHTSA), Department of Transportation.

ACTION: Denial of petition for a defect investigation.

SUMMARY: This notice sets forth the reasons for the denial of a petition submitted on December 19, 2019, by Mr. Brian Sparks to NHTSA's Office of Defects Investigation (ODI). The petition requests that the Agency recall Tesla vehicles for an unidentified defect that allegedly causes sudden unintended acceleration (SUA). NHTSA opened Defect Petition DP20-001 to evaluate the petitioner's request. After reviewing the information provided by the petitioner and Tesla regarding the alleged defect and the subject complaints, NHTSA has concluded that there is insufficient evidence to warrant further action at this time. Accordingly, the Agency has denied the petition.

FOR FURTHER INFORMATION, CONTACT: Mr. Ajit Alkondon, Vehicle Defects Division - D, Office of Defects Investigation, NHTSA, 1200 New Jersey Ave. SE, Washington, DC 20590 (telephone 202-366-3565).

SUPPLEMENTARY INFORMATION:

1.0 Introduction

Interested persons may petition NHTSA requesting that the Agency initiate an investigation to determine whether a motor vehicle or item of replacement equipment does not

comply with an applicable motor vehicle safety standard or contains a defect that relates to motor vehicle safety. 49 U.S.C. 30162; 49 CFR Part 552. Upon receipt of a properly filed petition the Agency conducts a technical review of the petition, material submitted with the petition, and any additional information. 49 U.S.C. 30162(c); 49 CFR 552.6. After considering the technical review and taking into account appropriate factors, which may include, among others, allocation of Agency resources, Agency priorities, and the likelihood of success in litigation that might arise from a determination of a noncompliance or a defect related to motor vehicle safety, the Agency will grant or deny the petition. 49 U.S.C. 30162(d); 49 CFR 552.8.

2.0 Petition

2.1 Petition Chronology

Mr. Brian Sparks (the petitioner) first submitted a valid petition conforming to the requirements of 49 CFR 552.4 on December 19, 2019.¹ On December 30, 2019, the petitioner submitted an addendum to his petition. This addendum references NHTSA complaint 11291423, which alleges unexpected movement of a vehicle that was parked and unoccupied.

On January 13, 2020, the Office of Defects Investigation (ODI) opened Defect Petition DP20-001 to evaluate the petitioner's request for a recall of all Tesla Model S, Model X, and Model 3 vehicles produced to date based on the information in his correspondence, petition and various addendums. On February 21, 2020, the petitioner submitted another addendum to his petition, identifying 70 new incidents of alleged SUA in NHTSA complaints (also known as Vehicle Owner Questionnaires, or VOQs) filed since DP20-001 was opened. Additional

¹ The petitioner first raised concerns about SUA in Tesla vehicles in September 2019 correspondence with the Agency. NHTSA did not consider this earlier correspondence to be a validly submitted petition because the petitioner did not provide his name and address. *See* 49 CFR 552.4. The September 2019 letter cited 110 incidents of alleged SUA in complaints to NHTSA, including 102 reporting crashes. NHTSA has included the information in petitioner's September 2019 correspondence in the Agency's analysis of the petition.

addendums updating VOQ counts were submitted on April 10, 2020, June 22, 2020, September 10, 2020 and December 1, 2020. The June 22 submission included a request to update the petition “to include a recent analysis of Tesla’s SUA defect from Dr. Ronald Belt.”

2.2 Petition Basis

Altogether, the petitioner identified a total of 232 VOQs involving unique alleged SUA incidents in his submissions, including 203 reporting crashes.² The petitioner also submitted a document purporting to analyze Event Data Recorder (EDR) data from the incident reported in NHTSA VOQ 11216155. The petitioner believes that “Tesla vehicles have a structural flaw which puts their drivers and the public at risk” and bases his request for a recall of the subject vehicles on:

1. His view that, “The volume of complaints in the NHTSA database indicates a severe and systemic malfunction within Tesla vehicles;”
2. A third-party analysis of data from the crash reported in VOQ 11206155, which theorizes a fault condition that allegedly “caused the brake pedal to behave like an accelerator pedal;” and
3. A complaint (VOQ 11291423) alleging SUA while the driver was outside the vehicle, which the petitioner describes as “the first SUA complaint involving a Tesla vehicle in which the driver cannot reasonably be accused of pressing the accelerator.”

3.0 Analysis

ODI performed the following analyses in its evaluation of the petition for a grant or deny decision:

² The petitioner identified a total of 225 VOQ in the original petition and five addendums. Six of the VOQs are duplicative of a prior VOQ.

1. Analyzed crashes identified by petitioner for connection to SUA;
2. Analyzed EDR or Tesla vehicle log data or both from 118 crash incidents;³
3. Reviewed the crash incident reported in VOQ 11206155;
4. Reviewed the crash incidents reported in VOQ 11291423;
5. Reviewed Tesla's system safeguards for the accelerator pedal position sensor (APPS) assembly and motor control system;
6. Reviewed two defect theories referenced in the petition;
7. Reviewed the brake system designs for the subject vehicles; and
8. Reviewed service history information for the accelerator pedal assemblies, motor control systems, and brake systems for 204 of the 232 vehicles identified in VOQs submitted by the petitioner.⁴

3.1 Crash Classification

ODI's crash analysis reviewed 217 incidents, including the 203 crashes identified by the petitioner and fourteen additional crashes reported in VOQs that were either not selected by the petitioner (eight) or were submitted after the petitioner's most recent submission (six).

Table 1 provides a breakdown of the driving environments and crash data review for the crashes analyzed by ODI. Crash data (EDR, Tesla log data, and/or video data) were reviewed for 118 of the crash incidents. Crash data were not obtained for most of the incidents received after DP20-001 was opened.

³ This information was not available or not obtained for the remaining crash incidents, as detailed below.

⁴ ODI's information request letter for DP20-001 requested crash data and service history information for all 124 VOQs cited in the original petition and the first two addendums submitted by the petitioner. On February 10, 2020 and October 20, 2020, ODI requested certain supplemental information, for a total of 83 additional VOQs alleging crashes, including 80 that were cited in addendums submitted by the petitioner.

Category	Crash data reviewed	Crash data not available	Crash data not obtained	Total
Parking lot	61	44	9	114
Driveway	26	16	4	46
Traffic light	11	7	2	20
Parking garage	7	5	1	12
City traffic	3	1	0	4
Stop-and-go traffic	2	2	0	4
Highway traffic	2	1	1	4
Stop sign	2	1	0	3
Charging station	1	1	1	3
Street side parking	1	1	0	2
Drive thru	1	0	1	2
School drop-off lane	1	0	0	1
Car wash	0	1	0	1
Gated exit (China incident)	0	1	0	1
Total	118	80	19	217

Table 1. Summary of crash incidents reviewed by ODI.

Six of the crashes reported by the petitioner were assessed by ODI as unrelated to SUA. These include all four of the crashes occurring in highway traffic, one crash at a traffic light and one of the driveway crashes. The highway crashes include two involving loss of lateral control due to apparent loss of rear tire grip while driving in the rain (VOQs 11297507 and 11307255), one involving late braking for the cut-in of a slower moving vehicle (VOQ 11278322), and one for which the crash data do not support the allegation and show no evidence of speed increase or failure to respond to driver inputs (VOQ 11174732). The crash at a traffic light involved unexpected movement of a vehicle operating with Traffic Aware Cruise Control enabled after the vehicle had come to a stop behind another vehicle at a red light (VOQ 11307023). The driveway crash incident will be reviewed later in this report (VOQ 11291423).

All of the remaining 211 crashes, assessed by ODI as related to SUA, occurred in locations and driving circumstances where braking is expected. Eighty-six (86) percent of these crashes occurred in parking lots, driveways or other close-quarter “not-in-traffic” locations.

Almost all of these crashes were of short duration, with crashes occurring within three seconds of the alleged SUA event.

3.2 SUA Crash Data Analysis

ODI's analysis of EDR data, log data or both from 118 crashes did not identify any evidence of a vehicle-based cause of unintended acceleration or ineffective brake system performance in the subject vehicles. The data shows that vehicles responded as expected to driver accelerator and brake pedal inputs, accelerating when the accelerator pedal is applied, slowing when the accelerator pedal is released (generally in regenerative braking mode) and slowing more rapidly when the brake is applied. ODI did not observe any incidents with vehicle accelerations or motor torques that were not associated with accelerator pedal applications. In the few cases where the brake and accelerator pedal were applied at the same time, the brake override logic performed as designed and cut motor torque.

The data clearly point to pedal misapplication by the driver as the cause of SUA in these incidents. Analysis of log data shows that the accelerator pedal was applied to 85 percent or greater in 97 percent of the SUA crashes reviewed by ODI. Peak accelerator pedal applications were initiated within two seconds of the collisions in 97 percent of the cases. Analysis of brake data showed no braking in 90 percent of SUA crashes and late braking initiated less than one second before impact in the remaining 10 percent. The pre-crash event data and driver statements indicate that the SUA crashes have resulted from drivers mistakenly applying the accelerator pedal when they intended to apply the brake pedal. Approximately 51 percent of the crashes occurred in the first six months of the driver's use of the incident vehicle.

3.3 VOQ 11206155

3.3.1 Consumer's Description of the Event.

NHTSA complaint 11206155 alleges that a 2018 Tesla Model 3 experienced an SUA event resulting in a crash in the owner's driveway on the evening of May 6, 2019. The complaint states that:

"[The driver] turned into [the driver's] driveway and was going to pull into [her] garage to park the car, when the car accelerated suddenly and violently and crashed into the front stone wall of [the] house. The stone wall is damaged and the front right side of the Tesla has significant damages."

The petitioner referenced the incident reported in VOQ 11206155 in the first addendum to the petition,⁵ which included a third-party analysis of EDR data from the crash. ODI requested a copy of the EDR data in the petition acknowledgement letter. In response, the petitioner provided an incomplete copy of the EDR, a copy of a letter Tesla sent to the consumer, and a document prepared by the driver that provides additional details about the SUA allegation.⁶ The driver alleges that the SUA event occurred after the vehicle was "slowed to a halt" and while the driver was "waiting for the garage door to fully open."

3.3.2 Tesla Letter to the Consumer.

In a July 11, 2019 letter, Tesla provided the consumer with the following summary of its analysis of log data for the crash event reported in VOQ 11206155:⁷

⁵ E-mail from Brian Sparks to NHTSA Acting Administrator Owens, "Motor Vehicle Defect Petition: Recall Tesla Vehicles Due to Sudden Unintended Acceleration," December 19, 2019.

⁶ E-mail from Brian Sparks to ODI, "Re DP20-001 Acknowledgement Letter," February 21, 2020, attachment titled "My Experiences with Tesla Model 3."

⁷ Tesla service manager, letter to the consumer, July 11, 2019.

“According to the vehicle's diagnostic log, immediately prior to the incident, the accelerator pedal was released, regenerative braking was engaged and slowing the vehicle, and the steering wheel was turned to the right. Then, while the vehicle was traveling at approximately 5 miles per hour and the steering wheel was turned sharply to the right, the accelerator pedal was manually pressed and over about one second, increased from approximately 0% to as high as 88%. During this time, the vehicle speed appropriately increased in response to the driver's manual accelerator pedal input. In the next two seconds, the accelerator pedal was released, the brake pedal was manually pressed, which also engaged the Anti-Lock Braking System, multiple crash-related alerts and signals were triggered, and the vehicle came to a stop.”

3.3.3 ODI Analysis of the Event.

ODI's analysis of the subject crash event included reviews of vehicle log data, the EDR report furnished by the petitioner, statements from the driver, and a video of the incident provided by Tesla. This analysis confirmed the sequence of events described in Tesla's letter to the consumer. Figure 1 shows pre-crash vehicle speed and driver controls over the ten seconds prior to impact.

ODI's review of the vehicle log data shows that, approximately seven seconds before the crash, the vehicle is completing a right turn as the steering angle returns from a large positive value to neutral. Over the next second, the driver releases the accelerator pedal and the vehicle begins a moderate deceleration under regenerative braking. The vehicle begins to turn right toward the owner's driveway approximately five seconds before impact. Approximately two seconds before impact, as the vehicle nears the apex of the turn into the driveway, the accelerator pedal position begins to increase. The accelerator pedal increases from 0% to 88% in about one

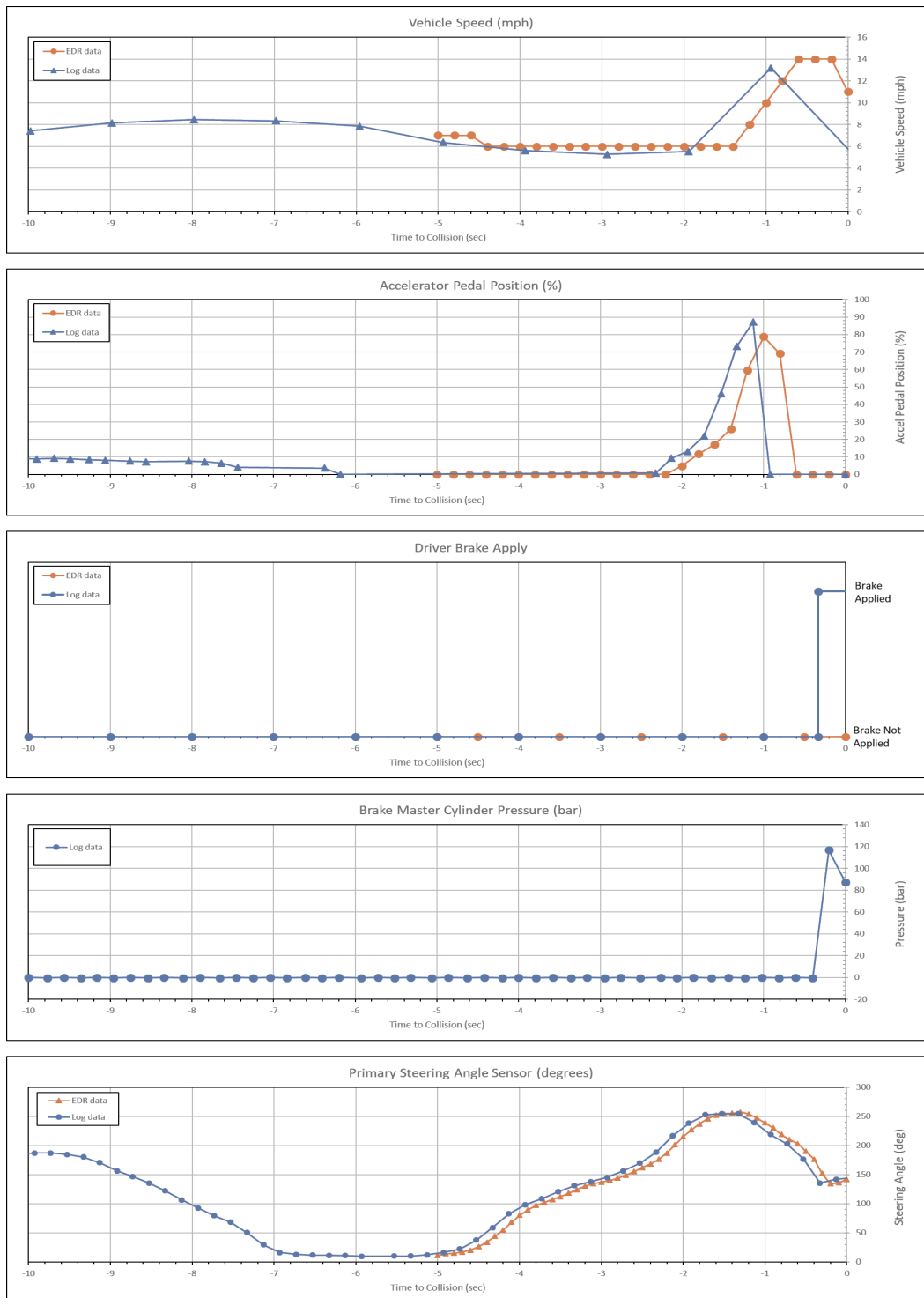


Figure 1. Pre-crash operator control data, from top-to-bottom: vehicle speed, accelerator pedal position, brake pedal application, brake master cylinder pressure, and steering angle.

second. The accelerator pedal returns to 0% approximately 0.9 seconds before impact and the brake pedal is applied approximately 0.5 seconds later. The late brake application initiates ABS braking approximately 0.2 seconds before impact.

3.3.4 ODI Analysis of Event Video File.

An event video file from the vehicle's front camera sensor shows the vehicle moving slowly on a residential street before beginning the right turn into a short driveway with a moderate positive grade leading to twin garage doors separated by a center pillar covered by stonework. The vehicle briefly surges forward as it nears the apex of the turn into the driveway. The vehicle never stops moving and continues to turn right until impacting the center pillar, consistent with the steering angle data from the log and EDR data. The garage doors remain closed throughout the event.

3.3.5 ODI Analysis of EDR Data.

The EDR vehicle speed, accelerator pedal position and steering angle data mirror the log data, within the range of expected variation due to differences in data resolution, sampling intervals and data latencies in the two data recording systems. For example, the vehicle speed data reported in the EDR report for the Model 3 has a resolution of 1 mph, a sampling frequency of 5 Hz, and a maximum latency of approximately 200 milliseconds, while the vehicle speed data recorded in the log data has a resolution of 0.05 mph, a logging rate of 1 Hz, and a maximum latency of approximately 10 milliseconds.

The EDR did not record the late brake application and subsequent ABS activation. The data log shows that the Restraint Control Module (RCM) echoed the brake application in the near deployment alert triggered by the impact, indicating that the EDR would be expected to

show “On” for service brake status at impact. Tesla indicated it was unable to investigate the apparent discrepancy further without an original copy of the EDR report.⁸

ODI’s reviews of EDR reports for this and several other Model 3 crash events noted that the polarity of the pre-crash longitudinal acceleration data appeared to be reversed in relation to vehicle speed data (i.e., negative acceleration displayed when the vehicle speed is increasing and positive acceleration displayed when vehicle speed is decreasing).⁹ Tesla confirmed that the longitudinal acceleration data polarity was reversed in Model 3 EDR reports produced using EDR reporting services of v20.2.1 or earlier. Tesla advised ODI that the error has been corrected in EDR reporting service update v20.29.1.

3.4 Analysis of Log Data for VOQ 11291423

VOQ 11291423 alleges multiple incidents of unexpected movement of a 2015 Model S after parking on an inclined driveway in Lancaster, California on December 26, 2019. The complaint states that:

“[The] 2015 Model S 85D was reversed onto driveway then placed in park and doors were closed and locked. A few moments later the vehicle started accelerating forward towards the street and crashed into a parked car. Front wheels were receiving power while rear wheels were locked and dragging rather than wheels spinning. I reversed vehicle back onto driveway and it happened another 2 times after first incident within a 30 minute time span.”

As previously noted, the petitioner’s addendum cited this VOQ as an “SUA complaint involving a Tesla vehicle in which the driver cannot reasonably be accused of pressing the

⁸ This is the only event reviewed by ODI in this petition evaluation where the data log showed the brake was applied at T0 and the EDR did not.

⁹ Acceleration (a) is the change in velocity (v) per unit time (t), or $a(T) = \frac{dv}{dt}$. When vehicle speed is increasing over a given time interval, the acceleration is positive in that interval.

accelerator.” When interviewed by ODI, the owner stated that the vehicle was backed up an inclined driveway and parked. The driveway was covered with freshly fallen snow. Shortly after he shifted to “park” and exited the vehicle, the owner observed the vehicle move approximately two car lengths down the driveway.

The movement stopped when the vehicle reached the level surface of the street at the base of the driveway. The owner alleged the movement occurred two more times after the vehicle was backed up the driveway and parked in a similar position. The second incident involved a minor impact with a vehicle parked within a couple of feet of the Tesla, resulting in a crack in the front bumper of the second vehicle and no damage to the Tesla. The third incident was like the first, with the movement ending at the base of the inclined driveway.

ODI’s review of log data from this vehicle found that the movement occurred when the vehicle was shutoff with no torque applied to the front or rear drive motors. Based on the log data and the physics of the vehicle movement from the driveway to the street, it is ODI’s assessment that the unexpected movement of the parked vehicle was most likely caused by insufficient traction of the rear tires on the low-friction surface of the snow-covered driveway, which resulted in the vehicle sliding down the driveway. ODI has excluded this incident from its analysis of SUA crashes.

3.5 System Safeguards

The APPS system used in the subject Tesla vehicles has numerous design features to detect, and respond to, single point electrical faults, including: redundant position sensors, contactless inductive sensing technology, independent power and ground connections to the sensors, and sensor voltage curves that differ by a fixed ratio.¹⁰ All subject vehicles are equipped

¹⁰ Second channel output voltage curve is half the slope of the first channel.

with accelerator pedal assemblies with two independent inductive sensors that convert the angular position of the pedal to voltage signals. The pedal position can only be changed in response to an external force being applied, such as the driver's foot.

The Drive Inverter main processor controls motor torque based on accelerator pedal voltage. A separate processor (Pedal Monitor) acts as a safety monitor, continually checking both APPS signals for faults and independently calculating motor torque. Any malfunction or deviation in the APPS system results in a fault mode, cutting torque to zero for driver pedal applications or regenerative braking. In addition, the Pedal Monitor can shut off the Drive Inverter if driver's commanded motor torque and actual motor torque do not match.

The APPS voltage signals pass through A/D (Analog/Digital) converters in the drive unit, which then reports the data to the Controller Area Network (CAN) communication bus.¹¹ The CAN data are time stamped and stored at specified intervals by the data log. The RCM receives the data from the drive unit via the CAN bus. The data is buffered in the RCM random access memory (RAM) and then written to the RCM Electrically Erasable Programmable Read-Only Memory (EEPROM)¹² in the event of a non-deploy or deployment event.

3.6 ODI Review of SUA Theories

As part of its evaluation of DP20-001, ODI reviewed two defect theories alleging vehicle-based causes of SUA in the subject vehicles. Both theories were developed by Dr. Ronald Belt, the first in 2018 and the second in 2020. A paper describing the most recent theory was submitted to NHTSA by the petitioner and is based upon Dr. Belt's review of EDR data from the crash reported in VOQ 11206155. The other theory was referenced by the consumer

¹¹ The APPS data refresh rate is 10 milliseconds.

¹² The EEPROM is a non-volatile memory device that retains stored data after cycling power.

who submitted VOQ 11206155 and is based upon Dr. Belt's third-hand reconstruction of log data from an unknown SUA event. Both papers are based upon incorrect event data, incorrect reconstructions of event dynamics, and false assumptions regarding vehicle design factors.

3.6.1 2020 Theory (VOQ 11206155 SUA Event)

In an addendum to the petition submitted on June 22, 2020, the petitioner requested that NHTSA include a recent paper by Dr. Ronald Belt in his petition.¹³ The paper, dated June 1, 2020, claims to explain how a “faulty brake light switch [caused] the brake pedal to behave like an accelerator pedal” in the crash event reported in VOQ 11206155 that was reviewed earlier in this report (see section 3.3 VOQ 11206155). The same analysis alleges that the proposed theory “is believed to be the cause of sudden acceleration in over 70% of Tesla vehicles.”

The SUA theory proposed by Dr. Belt in the June 2020 paper appears to have originated from his reliance on the pre-crash longitudinal acceleration data in the EDR report with the polarity issue recently corrected by Tesla (see section 3.3.5 ODI Analysis of EDR Data). Rather than recognizing the conflicts between the longitudinal acceleration data and other pre-crash data in the EDR report (e.g., vehicle speed, rear motor speed and accelerator pedal position all increasing over the same time interval as the reported deceleration), Dr. Belt develops his reconstruction of the crash event using the inverted longitudinal acceleration data and posits a theory to explain how a faulty brake light switch can cause the brake pedal to function like an accelerator pedal. The theory relies upon numerous assumptions, including: a defective brake switch, a large positive torque request from the electronic stability control (ESC) system, an

¹³ Belt, Ronald. “Tesla Regen, Brakes and Sudden Acceleration.” Center for Auto Safety, June 1, 2020. <https://www.autosafety.org/wp-content/uploads/2015/03/Tesla-Regen-Brakes-and-Sudden-Acceleration.pdf>

alternate explanation for the large accelerator pedal position increase shown in the pre-crash data, and an alleged veer to the left caused by the presumed ESC activation.

ODI does not believe that Dr. Belt's June 2020 paper provides a valid theory of an SUA defect in the subject incident or any other crash. The theory is based upon inaccurate event data and several false assumptions regarding component defects, vehicle dynamics, and motor control system design and operation. For example, ODI notes the following factual errors and mistaken assumptions contained the subject paper:

- The vehicle acceleration data used by Dr. Belt in his analysis was reported with the polarity reversed. In other words, the data shows the vehicle decelerating when it was accelerating and accelerating when it was decelerating. As shown in Figure 1, the vehicle first accelerates in response to a large accelerator pedal application, then decelerates in response to the late brake application that triggered ABS braking just prior to impact.¹⁴
- The evidence shows that the brake light switch functioned as designed in the event analyzed by Dr. Belt (see Figure 1).
- The ESC and Traction Control systems cannot request positive torque in the subject vehicles.
- The APPS data recorded in the EDR report and data log show the physical position of the accelerator pedal (see section 3.5 System Safeguards). There is no other source for the accelerator pedal data.
- The vehicle does not veer to the left at any point during the crash event (see Figure 1 and section 3.3.4 ODI Analysis of Event Video File).

¹⁴ ODI estimates that the vehicle was within approximately five feet of the stone wall when ABS braking began.

3.6.2 2018 Theory (Unknown SUA Event)

ODI also reviewed an earlier paper by Dr. Belt suggesting a different theory for a vehicle-based cause of SUA in Tesla vehicles.¹⁵ This paper, dated May 1, 2018, was referenced in a supplemental submission from the consumer who submitted VOQ 11206155.¹⁶ The SUA theory proposed by Dr. Belt in the May 2018 paper originated from his reconstruction of accelerator position log data from an unknown SUA incident that was described to him over the phone.¹⁷ Based on this reconstruction, Dr. Belt concluded that the APPS signal could not have been produced by the driver's application of the accelerator pedal, as summarized below from the paper's abstract:¹⁸

“Examination of the data shows that the accelerator pedal sensor output increased to cause the sudden acceleration. But the increase in the accelerator pedal sensor output could not have been caused by the driver. Instead, the increase in the accelerator pedal sensor output appears to have been caused by a fault in the motor speed sensor, with which it shares a common +5V power and ground.”

Like his June 2020 paper, the theory proposed by Dr. Belt in the May 2018 paper is based upon inaccurate event data and false assumptions about system design. The APPS data is not recorded in Tesla's log data in the manner claimed in the paper (see section 3.3.5 ODI Analysis

¹⁵ Belt, Ronald. “Tesla's Sudden Acceleration Log Data– What It Shows.” Center for Auto Safety, May 1, 2018. <https://www.autosafety.org/wp-content/uploads/2015/03/Teslas-Sudden-Acceleration-Log-Data-What-It-Shows.pdf>

¹⁶ “My Experiences with Tesla Model 3,” p 10.

¹⁷ The paper provides the following explanation of how the accelerator pedal position data was reconstructed: “In this paper, the author has obtained the complete accelerator pedal sensor log data for a sudden acceleration incident from a driver who got the log data from Tesla during a telephone conversation. The Tesla engineer gave a detailed description of the log data to the driver, who then provided it to the author. The author then plotted this data to create the figure used in this study.”

¹⁸ Dr. Belt's reconstruction imagines the APPS log data as a square wave, which he asserts could not have been produced by a physical application of the accelerator pedal.

of EDR Data).¹⁹ In addition, circuit design information provided to ODI by Tesla shows that Dr. Belt's assumption that "[t]he two accelerator pedal sensors and the motor speed sensor share the same +5V regulator and ground," is incorrect. Tesla uses two distinct regulators with different voltage outputs to supply power to the APPS and motor speed sensors. Thus, the May 2018 paper does not provide a valid explanation for a fault-based cause of SUA in the subject vehicles. Based upon the reported increase in accelerator pedal position to 97 percent shortly before collision, the most likely cause of the incident described in the May 2018 Belt paper is pedal misapplication by the driver.

3.7 Brake System

The subject vehicles are all equipped with pedal-actuated hydraulic brake systems that are completely independent of the motor control system. No common fault has been identified or postulated that would cause simultaneous malfunctions of the brake and motor control systems in the subject vehicles. Power assist is provided either electro-mechanically or from a dedicated vacuum pump. In addition, all subject vehicles have Tesla's brake override logic that will cut motor torque if the brake and accelerator are applied at the same time. If the accelerator pedal is pressed before the brake pedal (or within 100 milliseconds of brake pedal), motor torque is reduced to zero. If the brake pedal is pressed and then the accelerator pedal, motor torque is limited to 250 Nm and motor power is limited to 50 kW. In the latter condition, the driver should be able to hold the vehicle stationary regardless of accelerator pedal position with 85 to 170 N (19 to 38 lbf) of brake pedal force, depending on the platform.

¹⁹ ODI does not believe that Dr. Belt's reconstruction of the log data is accurate. The data log is not capable of recording a square wave with 1 Hz sampling of the APPS data.

Finally, the subject vehicles also contain Tesla's Pedal Misapplication Mitigation (PMM) software which uses vehicle sensor data to identify potential pedal misapplications and cut motor torque to prevent or mitigate SUA crashes. ODI's analysis found evidence of PMM activation in approximately 13 percent of crashes where log data was reviewed for SUA crashes. The effectiveness of the PMM activations have been limited by the fact that the original PMM implementation is designed for conditions where the vehicle is traveling straight forward or rearward toward the collision obstacle. Most SUA crashes reviewed in this petition evaluation involved dynamic steering inputs (i.e., vehicles with steering angles of 180 degrees or greater when the SUA occurs) which the original implementation of PPM was not designed to address.

3.8 Complaint Vehicle Service History Review

ODI requested service histories for the accelerator pedal assemblies, motor control systems and brake systems for 204 of the vehicles cited by the petitioner. Only two vehicles had faults diagnosed in those components: one motor fault resulting in a vehicle stall allegation and the other an APPS fault that appears to have resulted from damage incurred by the force of the driver's foot on the pedal during the crash event.

One of the VOQs identified by the petitioner reported feeling a jerk forward when approaching a stop sign, then a complete loss of power (VOQ 11164094). The data logs from the vehicle show no increase in speed and the system cutting motor torque to zero in response to a drive inverter fault. ODI does not consider this incident a valid example of SUA.

Another vehicle had an accelerator pedal assembly replaced to repair a crash induced fault in one of the pedal tracks (VOQ 11180431). The data log shows increased drive motor torque in response to manual application of the accelerator pedal to 88.4 percent. After the fault in the pedal assembly was detected, motor torque was cut to zero within 0.04 seconds.

The service history analysis indicates that component faults are not a factor in the SUA incidents reported to NHTSA. The data logs for the two incidents that did involve component faults demonstrated that system failsafe torque cut logic worked as designed.

5.0 Conclusion

After reviewing the available data, ODI has not identified evidence that would support opening a defect investigation into SUA in the subject vehicles. The evidence shows that SUA crashes in the complaints cited by the petitioner have been caused by pedal misapplication. There is no evidence of any fault in the accelerator pedal assemblies, motor control systems, or brake systems that has contributed to any of the cited incidents. There is also no evidence of a design factor contributing to increased likelihood of pedal misapplication.

NHTSA is authorized to issue an order requiring notification and remedy of a defect if the Agency's investigation shows a defect in design, construction, or performance of a motor vehicle that presents an unreasonable risk to safety. 49 U.S.C. §§ 30102(a)(9), 30118. Given the fact that the event data do not provide evidence that the subject SUA was caused by a vehicle-based defect, it is unlikely that an order concerning the notification and remedy of a safety-related defect would be issued due to any investigation opened upon grant of this petition. Therefore, and upon full consideration of the information presented in the petition and the potential risks to safety, the petition is denied. The denial of this petition does not foreclose the Agency from taking further action if warranted, or the potential for a future finding that a safety-related defect exists based upon additional information the Agency may receive.

Authority: 49 U.S.C. 30162(d); delegations of authority at CFR 1.95 and 501.8.

Jeffrey Mark Giuseppe,

Associate Administrator for Enforcement.

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