National Transportation Safety Board

Washington, DC 20594

Highway Accident Brief

Single-Vehicle Run-Off-Road Crash and Fire
Fort Lauderdale, Florida, May 8, 2018

Accident Number:	HWY18FH013
Accident Type:	Single-vehicle run-off-road crash and postcrash fire
Location:	1300 block of Seabreeze Boulevard, Fort Lauderdale, Broward County, Florida
Date and Time:	May 8, 2018, 6:46 p.m. eastern daylight time
Vehicle:	2014 Tesla Model S P85D
Driver:	18-year-old male
Passengers:	18-year-old males (2)
Fatalities:	2
Injuries:	1

Crash Description

On Tuesday, May 8, 2018, at 6:46 p.m., a 2014 Tesla Model S electric-powered car occupied by an 18-year-old driver and two 18-year-old passengers was traveling south in the 1300 block of Seabreeze Boulevard, in Fort Lauderdale, Florida (figure 1), at a recorded speed of 116 mph. The driver and his passengers were on their way to the driver's residence from a nearby shopping mall, a trip of about 4 miles.

In this area, Seabreeze Boulevard consists of two northbound and two southbound lanes divided by a center turn lane. The posted speed limit is 30 mph. At the crash location, the roadway curves to the left for southbound traffic. The approach to the curve has a turn-warning sign indicating that the roadway turns left, augmented by a flashing beacon and a posted advisory speed of 25 mph (figure 2).

According to witnesses, the driver had maneuvered the car into the left lane and was passing another vehicle. The driver lost control while moving back into the right lane as he attempted to negotiate the curve. As the car exited the curve, it struck and mounted the curb on the west side of the road, crossed the sidewalk, and continued south, striking a wall on the north side of a residential driveway. The car continued forward and struck the wall on the south side of the driveway. Witnesses reported that flames came from the car after the second collision.

The car reentered the road, mounted the curb on the east side of Seabreeze Boulevard, struck a metal light pole, rotated, and came to rest in the driveway of an adjacent residence. The car was engulfed in fire. Both the driver and the front passenger died in the crash. The rear passenger was ejected during the crash and was transported to a local hospital with serious injuries. At the time of the crash, it was daylight, the weather was clear, and the road was dry.

Figure 1. Satellite view of crash location showing direction of travel, with inset map of Florida showing Fort Lauderdale. (Source: ESRI ArcGIS, with NTSB modifications)

Figure 2. (Left) southbound Seabreeze Boulevard with speed limit sign and turn-warning sign (circled in red); and (right) closeup of approach to curve with turn-warning sign, flashing beacon, and advisory speed sign.

Emergency Response

The Broward County Sheriff's Office call center received the first 911 call at 6:46 p.m. The caller reported that a vehicle had crashed into a wall, with fire and injured persons. Police units were dispatched at 6:47 p.m. and arrived on scene at 6:49 p.m. Fort Lauderdale Fire Rescue (FLFR) ladder 49 was dispatched at 6:46 p.m. and was the first fire unit on scene at 6:50 p.m. The first medical unit on scene was FLFR rescue 49, which was dispatched at 6:47 p.m. and arrived on scene at 6:50 p.m.

When they arrived on scene, units from the FLFR found the car fully engulfed in flames and the rear passenger sitting on the sidewalk. Firefighters immediately attacked the fire in an attempt to rescue the driver and the remaining passenger. They estimated that the interior fire was extinguished in under a minute. Firefighters reported that the heat from the fire was intense and that they could see electrical arcing. According to the FLFR, the fire was extinguished using 200 to 300 gallons of water and foam. Pieces of the car's lithium-ion high-voltage battery had separated from the vehicle and, as a precaution, firefighters applied water and foam to the debris.[1]

As part of the police investigation and cleanup, the vehicle and associated debris were loaded onto tow trucks. During that operation, modules that had separated from the battery ignited on the tow truck when workers passed a chain over them. The fire went out by itself. But while the vehicle was being loaded onto a second tow truck, the battery reignited, and the battery case

[1] The vehicle was equipped with a 12-volt direct-current (VDC) battery that powered the on-board systems and a 400-VDC lithium-ion traction battery that powered the front and rear drive motors. The pieces were from the traction battery.

separated from the vehicle. The fire department applied more foam and water to extinguish the fire. While being unloaded from the tow truck at the tow yard, the battery case and modules reignited a final time, but the fire again self-extinguished.

Injuries and Seat Belt Use

The driver and the front passenger died of thermal injuries.[2] The rear passenger sustained serious injuries. The vehicle was equipped with supplemental occupant restraints that included front and side air bags and seat belt pretensioners. Data from the vehicle's restraint control module (RCM) showed that both the driver's and front passenger's lap/shoulder belts were buckled at the time of the crash, and that all eight of the car's air bags deployed.[3] The rear passenger told investigators that he was unbelted.

When examined by responding medical personnel, the rear passenger was conscious and oriented but did not recall the events of the crash. He was observed to have skin abrasions ("road rash") but did not exhibit any thermal injuries or signs of exposure to fire or heat. He was taken by ambulance to a local hospital, where medical personnel found a fracture on the right side of his pelvis, two cracked ribs on his left side, two fractures of his right clavicle, and an injury to his left shoulder.

Roadway

Around the collision site, Seabreeze Boulevard, also known as Florida State Route (SR) A1A, is an urban minor arterial. The area is primarily residential. The section of Seabreeze Boulevard where the crash occurred is considered a north-south highway and is generally oriented as such.

Bike lanes run next to the right lane on both sides of the road and are delineated by pavement markings. The curbs are elevated above the road and abut either the concrete sidewalk or a narrow, grassy strip that separates the curb from the sidewalk. Typical dimensions in the area are as follows:

- Travel lanes: about 10 feet wide.
- Center two-way left-turn lane: about 9 feet wide.
- Bike lanes: about 4 feet wide.
- Sidewalks: from 4.5 to 5.0 feet wide.
- General cross-slope superelevation, excluding curves: 0.01 to 0.04 percent for the left lane, 0.01 to 0.06 percent for the right lane.

The travel lanes are delineated by pavement markings and retroreflective raised markers. The road underwent resurfacing and rehabilitation in June 2017.

[2] The front passenger also sustained blunt impact injuries to the head and torso. The medical examiner further noted that he died of a combination of thermal and blunt impact injuries.

[3] The air bags were all in the front of the car.

Signage

A speed limit sign facing southbound traffic was posted 474 feet north of the curve where the crash occurred. A turn-warning (W1-1) sign and a 25-mph advisory speed plaque (W13-1P) were posted facing southbound traffic 171 feet before the start of the curve.[4] An amber flashing warning beacon was posted above the turn-warning sign. The beacon was functioning at the time of the National Transportation Safety Board (NTSB) on-scene investigation.

Traffic Volume

The Florida Department of Transportation (FDOT) supplied annual average daily traffic (AADT) counts for sites approximately 1 mile north and 0.45 mile south of the crash site. At the northern site, the AADT in 2017 was 13,000 vehicles northbound and 13,500 vehicles southbound. For the southern site, the AADT in 2017 was 16,500 vehicles northbound and 17,500 vehicles southbound. The AADT was consistent over the previous 5 years, ranging from 26,000 to 31,000 at the northern site and from 28,500 to 34,500 at the southern site.

Crash History

FDOT supplied crash data from 2011 to 2015 for a 0.34-mile segment of Seabreeze Boulevard that encompassed the crash location. In all, 52 crashes were reported for the segment during those years. Thirty-nine were property-damage-only crashes, and 13 caused injuries (28 people were hurt). No fatal crashes were reported.

Investigators determined that 3 of the 52 crashes occurred in the curve where this crash began. Two crashes were rear-end impacts during daylight hours on a dry road. The third was a single-vehicle run-off-road collision with a curb that happened during daylight hours under cloudy conditions on a wet road.

Speed Study

FDOT provided data from a speed study conducted in August 2015 for SR-A1A between Mayan Drive and Bahia Mar, a distance of about 1 mile, which encompasses the curve where the crash occurred. Southbound, the 85th-percentile speed at the observation site closest to the crash site was 41 mph. Northbound, the 85th-percentile speed at the observation site closest to the crash site was 38 mph. At the time of the study, the posted speed limit was 30 mph, as it was at the time of the crash.

2014 Tesla Model S P85D

General

The 2014 Tesla Model S was purchased in December 2014 and was owned by the driver's family through a limited liability company. The model code P85D denotes that the vehicle was the

[4] The sign, beacon, and plaque can be seen in figure 2.

performance model (P), had an 85-kilowatt-hour (kWh) battery, and had dual-drive motors (D).[5] A search of the National Highway Traffic Safety Administration's recall database found two incomplete recalls for the car; neither was a factor in the crash.[6]

Battery

The vehicle's 400-VDC, 85-kWh lithium-ion traction battery was located under the floor of the car and spanned an area from the front tires rearward. The battery was divided into 16 modules (numbered from rear to front), plus a compartment for the battery management system. Each module contained individual battery cells stacked vertically. Figure 3 shows the fire-damaged battery. Modules 15 and16, at the front of the car, were the most severely burned.

Figure 3. Photo of battery showing fire-damaged region at front that contained modules 15 and 16, loose individual cells (rust-colored), vertically stacked cells below loosened covers, and orange insulation caps covering high-voltage terminals.

Damage

The vehicle was almost completely destroyed by the crash and fire. The largest remaining parts were the chassis, left (driver-side) wheels, body, and interior. Both right (passenger-side) wheels and some suspension components, the entire traction battery pack, both front doors, the right front fender, the front electric drive motor, the hood, and the front of the car had separated from the body. The vehicle had extensive fire damage, with the most severe damage in the middle front of the passenger compartment.

[5] Tesla has changed the hardware it uses on its vehicles several times. This vehicle was equipped with hardware version 1, which consisted of a camera, forward-looking radar, and ultrasonic acoustic sensors.

[6] The first recall involved aluminum bolts that could corrode in high-corrosion environments; the second involved the inflator for the passenger front air bag.

The left (driver) side of the car exhibited minor-to-moderate crash damage along its length. Thermal damage was minimal and limited to the left front fender, forward of the wheel (figure 4).

Figure 4. Left side of car showing minor-to-moderate crash damage and limited fire damage.

On the right (passenger) side, impact damage extended from the rear wheel all the way forward (figure 5). All window glass on the right side was broken out. The entire aft half of the right rear door was deformed forward. The right front corner of the car had significant missing parts, including the A-pillar, upper body frame, and entire front body. The right front door had separated from the body and exhibited severe thermal damage and a large vertical deformation pattern whose dimensions were similar to the light pole the car struck. Both right wheels were separated from the body; neither exhibited fire damage.

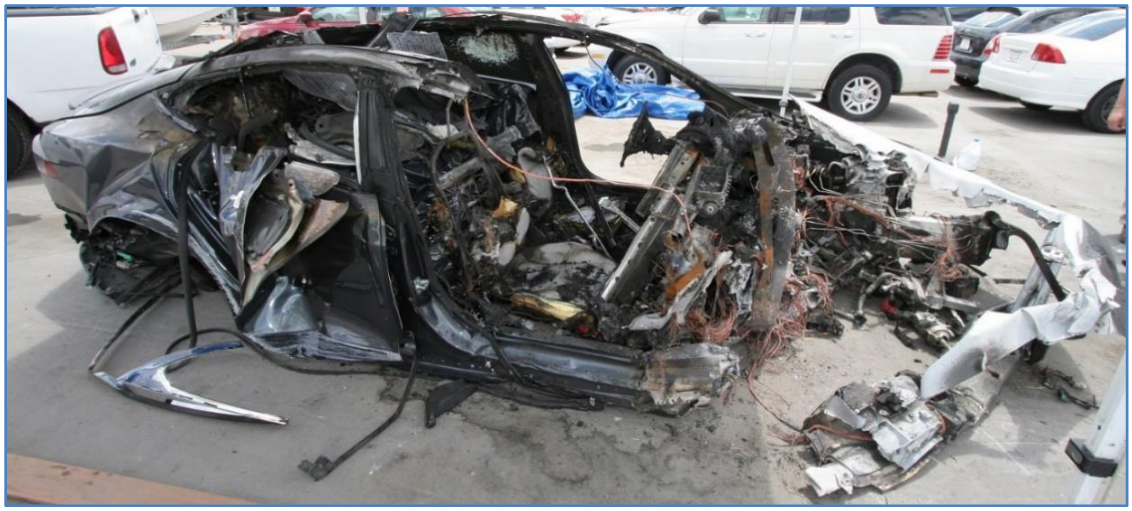

Figure 5. Right side of car, showing severe crash and fire damage.

The car's interior was severely fire-damaged. The front dashboard area was consumed by fire. The front seats were heavily fire-damaged, and large portions of the cushions were burned away. The rear seating compartment had severe thermal damage, but the seat cushions were mostly intact. Figure 6 shows fire damage to the vehicle interior and crash damage to the front.

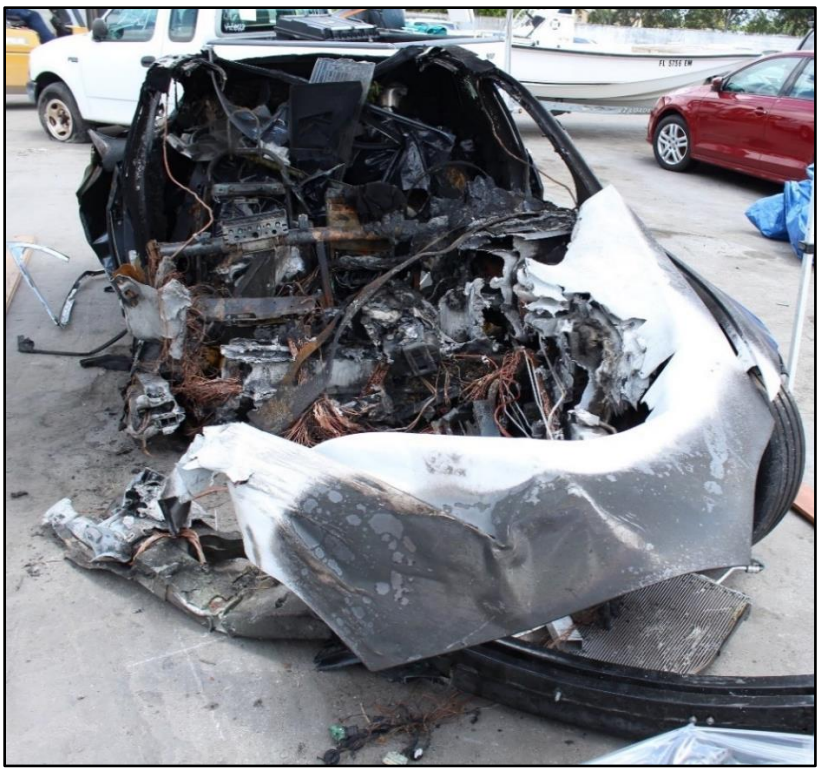

Figure 6. Front of car, showing severe crash damage and significant interior fire damage.

The 400-VDC, 85-kWh lithium-ion battery sustained damage. It was slightly twisted, with the right front corner raised. That corner was crushed on about a 45-degree diagonal and raised above the rest of the battery. The steel top of the battery case was pushed back and exhibited corrosion typical of severe heat exposure. The contents of battery modules 15 and 16 were found separated from the battery, and the module 15/16 portion of the battery case was empty. Loose battery cells were found in the passenger compartment and outside the vehicle. Holes were found in the steel top of the battery case, matching holes in the bottom of the passenger-side floorboard. The holes were caused by electrical arcing at high-voltage terminals and individual cells exploding, as a result of crash damage to the battery case and the battery fire.

Electronic Event Data

Deployment or activation of the car's supplemental restraints and safety devices is commanded by the air bag or RCM based on a programmed algorithm. In case of a deployment command or a nondeployment event when the command algorithm is enabled, certain data will be stored. The storing of "event" data defines this capability of the RCM as an event data recorder (EDR). The EDR functionality of the RCM adheres to the requirements of Title 49 *Code of Federal*

Regulations (CFR) Part 563.[7] The RCM data for the crash vehicle were retrieved by investigators using the Tesla RCM tool with EDR Retrieval Program software.[8] The data imaged from the RCM were interpreted by Tesla representatives using the Tesla EDR Reporting Service software.

Crash Data

According to the EDR report, one event was recorded, with several supplemental systems deployed. The driver- and passenger-side air bags, knee bolsters, and seat belt retractors were issued a deployment command 55 milliseconds after the algorithm was enabled. The high-voltage battery disconnect was triggered at the same time. Roll data indicate a counterclockwise roll (toward the driver's side) at approximately the same time the algorithm was enabled. The side curtain air bags on the driver and passenger sides and both front air bags received deployment commands at 494 and 530 milliseconds, respectively.

Precrash RCM Data

Precrash RCM data reported certain vehicle parameters for up to 5 seconds before time zero (algorithm activation, first impact) at 0.5-second intervals. The reported parameters were as follows:

- Vehicle speed.
- Percent accelerator pedal.
- Rear motor rotations per minute (rpm).
- Service brake.
- Steer angle.
- Stability control antilock braking system activity.

Precrash data from the RCM are summarized in the table. The data are consistent with manual vehicle operation. Although the car's advanced driver assistance systems were not recorded on the RCM, no indication was found that any (for example, lane-keeping assist or adaptive cruise control in Tesla's Autopilot suite) were active at the time of the crash. Data from the RCM are also consistent with the surviving passenger's account of the vehicle's speed.

[7] In summary, 49 CFR Part 563 defines an EDR as a device or function in a vehicle that records the vehicle's dynamic time-series data during the period just before a crash (for example, vehicle speed vs. time) or during a crash (for example, delta–V vs. time), intended for retrieval after the event. This regulation defines the minimum dataset that must be collected if a manufacturer decides to voluntarily install an EDR in its vehicle, along with requirements for the range and accuracy of the data. Part 563 applies to vehicles manufactured after September 1, 2010, and to vehicles with a gross vehicle weight rating of 8,500 pounds or less.

[8] An additional system, the media control unit, would normally also have recorded data; however, the crash and fire destroyed the data.

Table. Precrash RCM data.

Time	Parameter Value
5.0 seconds before impact	Vehicle speed 109 mph Accelerator pedal position 78% Steer angle slightly rightward Antilock braking system OFF (for entire dataset)
3.5 seconds before impact	Vehicle speed 115 mph Accelerator pedal position 74%
3.0 seconds before impact	Vehicle speed 116 mph Rear motor rpm increases from initial value Accelerator pedal position 0% Steer angle leftward with increasing angle
2.5 seconds before impact	Vehicle speed 114 mph Service brakes ON (for rest of dataset) Speed decreases Rear motor rpm decreases
2.0 seconds before impact	Vehicle speed 109 mph Stability control ENGAGED Leftward steering angle increases significantly Rate of longitudinal deceleration substantially increases

Video Analysis

Investigators obtained video recordings from three traffic cameras and one security camera along Seabreeze Boulevard that showed the car before the crash. The combined video was analyzed to observe the vehicle's movements and to estimate its speed in three segments.

The first segment shows the vehicle in the left lane, traveling behind a white car. The vehicle's estimated speed is 48 mph. The second segment shows the vehicle moving from the left lane to the right lane and passing the white car. The vehicle's estimated speed is 75 mph. The third segment shows the vehicle moving from the right lane to the left lane as it approaches the curve in the 1300 block of Seabreeze Boulevard. The vehicle's estimated speed is 112 mph. The third segment ends 4 seconds before impact.

Driver History

Licensing, History, and Precrash Activities

The driver, an 18-year-old male, held a class E Florida driver's license. He obtained a learner's permit in April 2015 and an operator's license in May 2016. According to his family, the driver was given the car at the end of 2017, making him the primary driver. The surviving passenger told investigators that the driver used the car daily and was familiar with the road near the crash site.

According to records from the Florida Department of Highway Safety and Motor Vehicles, the driver had received a traffic citation on March 3, 2018, for driving 112 mph in an area with a

50-mph speed limit. That was the only violation on his record. After the driver received the citation, his father forbade him from driving and contacted Tesla to see if speed restrictions could be placed on the car. On March 6, 2018, employees at a Tesla dealership placed the vehicle in "loaner" mode; that mode restricts the vehicle's maximum speed to 85 mph.[9]

The driver's father allowed him to resume driving with the restriction in place. The car was at the dealership for service from March 8 to April 3, 2018.[10] On April 4, 2018, employees at the dealership returned the car to normal operating mode at the request of the driver, who was empowered to make service decisions for the vehicle. On April 6, 2018, a judge held punishment in abeyance in exchange for the driver's attending a driver-improvement course and paying a fine.[11] According to his father, the driver had not started the course at the time of the crash.

Records from the driver's cell phone service provider show activity beginning about 5:00 a.m. the day of the crash and on each of the previous 3 days. The time of the last activity on the 3 days varied, but the driver had a sleep opportunity ranging from 7 to 11.5 hours each night. The records show that the driver's last voice or text activity occurred about 30 minutes before the crash.

The driver's family said that he was in good health, with no medical issues. Investigators found no current prescriptions for the driver.[12] When interviewed by police, the surviving passenger stated that he was unaware of the driver taking any medications on the day of the crash.

Toxicology

After the crash, the Broward County Medical Center performed toxicological tests on blood samples from the driver. The tests showed a carboxyhemoglobin saturation level of 11 percent.[13] Tests were negative for prescription, over-the-counter, or illicit drugs and ethanol (alcohol).[14]

[9] Tesla stated that loaner mode is intended only for service or fleet vehicles.

[10] The main battery in the vehicle was replaced because of charging issues.

[11] Legally, a plea in abeyance allows the court to dismiss a violation on completion of specified criteria: in this case, paying a fine or court costs and attending traffic school.

[12] Current prescriptions are ones the driver would have been taking at the time of the crash.

[13] Carboxyhemoglobin is formed when carbon dioxide bonds to hemoglobin in the blood. That decreases the oxygen available to the body and can lead to carbon dioxide poisoning. Normal concentrations are in the range of 1 to 2 percent. The elevated levels found in the driver indicate that he was breathing the byproducts of combustion before he died.

[14] According to the chief toxicologist of Broward County, the tests covered about 140 drugs.

Probable Cause

The National Transportation Safety Board determines that the probable cause of the single-vehicle run-off-road crash and postcrash fire in Fort Lauderdale, Florida, was the driver's loss of control as a result of excessive speed. Contributing to the severity of the injuries was the postcrash fire originating in the crash-damaged lithium-ion traction battery.

Report Date: December 13, 2019

For additional details about this crash, visit the NTSB public docket and search for NTSB accident ID HWY18FH013.
