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Special Crash Investigations: On-Site Electric Vehicle Fire Investigation; Vehicle: 2019 Chevrolet Bolt EV; Location: Florida; Incident Date: October 2020

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Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was submitted.

16. Abstract

This report documents the on-site inspection of a vehicle fire in a parked 2019 Chevrolet Bolt EV. The vehicle was unattended, parked, and charging in the owner's garage. The fire reportedly developed during the night.The homeowner awoke to the sound of an explosion and the odor of smoke. There were no injuries. A vehicle inspection, in conjunction with General Motors, determined that the fire originated in the battery compartment under the second-row seat cushion and spread throughout the entire vehicle and garage.

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Background

This report documents the on-site inspection of a vehicle fire that developed in a parked 2019 Chevrolet Bolt EV in 2020. The vehicle was unattended, parked, and charging in the owner's garage (Figure 1). The fire reportedly developed during the night. The homeowner awoke to the sound of an explosion and the odor of smoke. There were no injuries.

Figure 1. The 2019 Chevrolet Bolt EV parked in the garage

A vehicle inspection, in conjunction with General Motors (GM), determined that the fire originated in the battery compartment under the second-row seat cushion and spread throughout the entire vehicle and garage.

The National Highway Traffic Safety Administration's Special Crash Investigations group aided with further research in conjunction with representatives from GM in December 2020. Fire consultants advocating for the involved insurance company, a representative for the battery manufacturer, Ryobi,[1] an investigator for the attorney representing the owners, and a public insurance adjuster representing the owners were also in attendance. This inspection documented the potential source of the fire, damage to the vehicle, and damage to the surrounding structure. A complete interview with the vehicle's owners has not been obtained due to a legal dispute.

[1] Ryobi, Ltd., Hiroshima, Japan.

Summary

Incident Site

The incident occurred in the garage of a three-bedroom home (Figure 2) located in a residential area. The garage was designed for parking two vehicles. In addition to the Chevrolet, the garage contained personal items including battery-operated lawn equipment, battery-operated tools, a refrigerator, shelving, a workbench, holiday decorations, bikes, and other miscellaneous items. The Chevrolet was parked on the right side of the garage and plugged into a 220-volt outlet that ran to the fuse panel next to the outlet. The second homeowner stated that a local electrician installed the 220-volt outlet when the Chevy Bolt was purchased. The garage was enclosed by a tri-fold metal garage door on a belt-driven pulley system.

Figure 2. Incident site

The garage walls were constructed of concrete block covered by stucco. The roof's interior was braced by wooden 2x4 beams. The garage door opener was secured to a middle beam and operated by a remote or a push-button that was mounted on the wall next to the entry door to the house.

Pre-Incident

The first homeowner secured the vehicle in the garage and then plugged in the charger cable at approximately 2100 hours. He was unsure of the Chevrolet's state of charge. However, it was routine to charge the vehicle overnight. He then went inside the home and put the two children in bed. After getting the children to sleep, he did daily chores and then went to bed at approximately 2200 hours.

Incident

At about midnight he awoke to the sound of an explosion. He smelled smoke and ran to get the two children out of the house. He ran across the street and then looked back at his home. He noticed there was smoke coming from the house and he continued to hear small explosion noises. He ran to a neighbor's home and called emergency services.

Emergency fire and rescue arrived on the scene within 7 minutes and entered the home. At that time, emergency personnel noticed the origin of the fire was in the garage and began to extinguish the fire.

Post-Incident

After emergency personnel concluded that the fire had been extinguished, they confirmed that the house was not livable and advised the family. The second homeowner had left her work and arrived on scene at this time. The homeowners and their family gathered the belongings that they could salvage and went to a local hotel. The homeowner and children were not harmed in this incident.

The southern interior wall of the garage, shown in Figure 3, was partially destroyed due to the initial explosion and fire. Damage along this wall resulted in fire access to a child's bedroom in the home. The western exterior concrete block wall, indicated by the red arrow in Figure 3, was pushed outward a maximum of 10 cm (4 in) and damaged by the fire. The movement in these walls was believed to be the result of the initial explosion.

Figure 3. The 2019 Chevrolet Bolt EV in the garage post-incident

2019 Chevrolet Bolt EV

Description

The 2019 Chevrolet Bolt EV (Figure 4) was manufactured in October 2018 and identified by the Vehicle Identification Number (VIN) 1G1FZ6S00K4xxxxxx. The Chevrolet was a front-wheel-drive platform, powered by a permanent-magnet drive motor. Its service brakes were power-assisted 4-wheel disc with antilock brakes. The gross vehicle weight rating was 2,020 kg (4,453 lb). At the time of the inspection the Chevrolet had Michelin Energy Saver tires for the left-front and right-front tires. The left-rear and right-rear tires had been destroyed by the fire. The left-front and right-front tires had at least 6 mm (7/32) of tread. Additionally, the left-front and right-front tires were deflated and burned from the fire.

Figure 4. The 2019 Chevrolet Bolt EV

The Chevrolet's interior had seating for five (2 front/3 rear), with front-row bucket seats and a second-row bench seat (Figure 5) with split forward-folding seatbacks. The right-front, left-front, left-rear, and right-rear seating positions had adjustable head restraints. Manual restraint systems consisted of 3-point lap and shoulder seat belts for all seat positions. Supplemental restraint systems included front seat belt retractors and 10 air bags consisting of the driver's and passenger's frontal, driver and passenger knee, front and rear outboard seat-mounted side impact, and inflatable curtain air bags.

Figure 5. The 2019 Chevrolet Bolt EV second-row bench seat

Chevrolet Bolt 60 kWh Lithium-Ion Battery

The Bolt EV has a 60-kWh nickel-rich, lithium-ion, high-voltage battery that contains 288 individual nickel-lithium-ion cells. Three cells are welded together in parallel and are called a cell group. There are a total of 96 cell groups in the hybrid/EV battery assembly. These cell groups are electrically connected in series. Each individual cell group is rated at 3.5 volts, for a nominal system voltage of 344 volts of direct current. The battery cell groups are electrically joined to form 10 distinct electrical modules. There are 8 electrical modules comprised of 10 cell groups and 2 electrical modules comprised of 8 cell groups. Two battery cell modules are physically mounted together to form a section/row. Sections/Rows 1 and 3 are interchangeable, while sections/rows 2, 4, and 5 are unique to their respective locations. Except for section/row 5, the two battery cell modules are not electrically connected within their respective section/row. The hybrid/EV battery pack contains a total of six battery temperature sensors mounted to certain battery cell modules. The hybrid/EV battery pack also contains a coolant inlet temperature sensor.

Located within the high-voltage hybrid/EV battery pack is the K16 battery energy control module, which monitors the temperature, current, and voltage of the 96 battery cell groups. The voltage sense lines are attached to each individual cell group, and these sense lines terminate at a connector located on the end of the battery cell module. A voltage sense harness joins this connector to the battery energy control module, which determines when a fault condition is present. Diagnostics and system status are communicated from the battery energy control module to the K114B hybrid/EV powertrain control module 2 through serial data. The hybrid powertrain control module 2 is the host controller for the battery energy control module diagnostic trouble code information.

Battery charging was achieved through a cable connected to a 220-volt outlet. A mobile application connected to the Chevrolet aided the vehicle owner in monitoring the battery's charge state.

NHTSA Recalls and Investigations

An initial query of the NHTSA recall database (www.nhtsa.gov/recalls) made in December 2020 using the VIN for this specific Chevrolet Bolt indicated there was an unrepaired recall for this vehicle. The vehicle manufacturer issued a recall of 50,932 Chevrolet Bolts in November 2020 due to the potential of unattended fires in the lithium-ion battery under the second-row seat cushion. This recall was issued on July 23, 2021 and advised owners to park the vehicle outside and not to charge it overnight. The manufacture recall number is N212343881 and the NHTSA recall number is 21V560.

The recall indicated that high-voltage batteries in these vehicles may pose risk of fire when the charge of the battery is full or close to full. Additionally, the recall indicated that vehicle dealers will replace the battery packs in the vehicles.

An additional query was made in May 2023. The vehicle manufacturer had issued an additional recall due to the potential of a fire occurring in or near the B-pillar following a crash that causes the pretensioner to deploy. This recall was issued on December 15, 2022. The manufacture recall number is N222383791 and the NHTSA recall number is 22V930.

Fire Damage and Observations

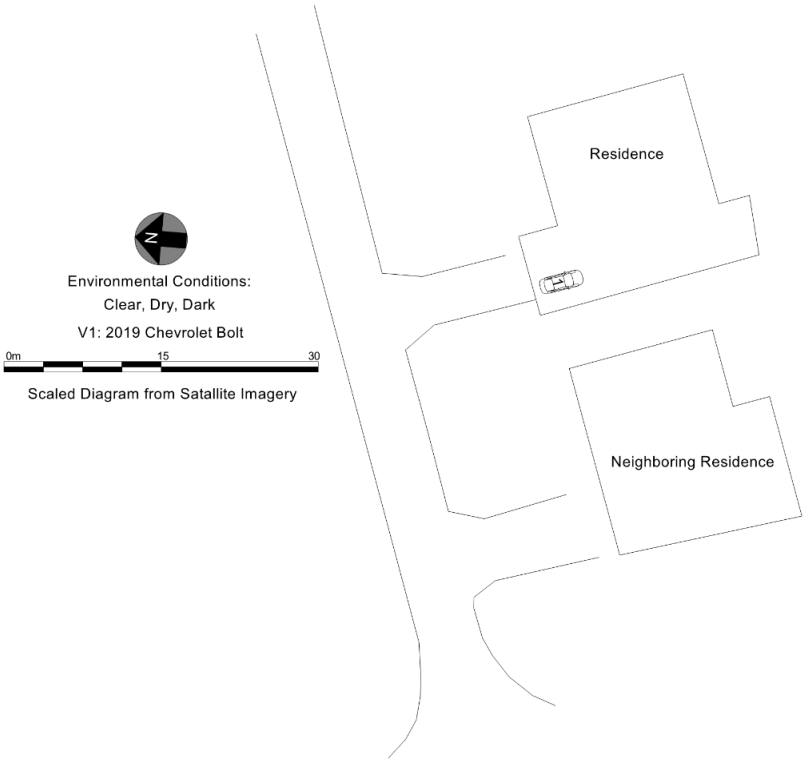
The Chevrolet's interior and exterior were destroyed by the fire. Upon removing the Chevrolet from the garage there was evidence of extreme heat and fire damage on the garage floor (Figure 6) directly under the second-row-left seat. The yellow arrow in Figure 6 indicates the location of the Chevrolet's rear bumper. The red arrow in Figure 6 shows the approximate location of the left rear wheel.

Figure 6. Fire damage to the garage floor under the left side of the vehicle

During the fire due to heat and chemical reaction, pressure built up in the battery cells. The GM representative said the initial explosion heard by the homeowner was likely the release of pressure through the rear aspect of the battery's containment. According to the GM representative, the smaller explosions heard by the homeowner were the progressive over-pressure releases of the battery cells in a domino-like effect. Some of the smaller explosions heard could have also been from rechargeable lawn equipment batteries located on top of a tool chest and plugged into a 110-volt outlet.

The GM representative suspected that the fire originated in the left cells of the lithium-ion battery, based on burn patterns on the garage floor. However, the GM representative said an exact determination could not be made at the time of the inspection. Additional evidence could not be obtained during the inspection due to the extent of the fire damage. At the time of this report, the Chevrolet is being stored off-site in a secured trailer by the insurance company's fire consultant.

Scene Diagram



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