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Special Crash Investigations: On-Site Passenger Air Bag Inflator Rupture Crash Investigation; Vehicle: 2006 Nissan Sentra; Location: Kentucky; Crash Date: February 2021

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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 published.

16. Abstract

This report documents the frontal crash of a 2006 Nissan Sentra and the passenger frontal air bag inflator rupture. The front of the Nissan struck the rear of a 2014 Lexus CT200 stopped in a line of traffic. The Lexus was displaced forward and struck the rear of a stopped 2018 Chevrolet Cruze. An unbelted 31-year-old female driver and an unbelted 37-year-old male passenger occupied the Nissan. The male in the Nissan sustained police-reported incapacitating (A-level) face/head trauma due to the air bag inflator rupture. The female driver sustained police-reported non-incapacitating (B-level) injuries to her upper extremities. A search of the NHTSA recall database www.nhtsa.gov/recall stated that the vehicle under investigation had one incomplete recall: NHTSA Campaign Number: 15V-287, issued May 14, 2015. It involved the recall of certain Nissan vehicles equipped with passenger frontal air bags included in the scope of the Takata air bag defect population. A vehicle history report stated the Nissan had five owners during its service life, which ended with the February 2021 crash. The passenger frontal air bag recall was issued during the fourth ownership.

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Office of Defects Investigation
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Background

This report documents the frontal crash of a 2006 Nissan Sentra (Figure 1) and its ruptured passenger frontal air bag inflator. The front of the Nissan struck the rear of a 2014 Lexus CT200 stopped in a line of traffic. The Lexus was displaced forward and struck the rear of a stopped 2018 Chevrolet Cruze. An unbelted 31-year-old female driver and an unbelted 37-year-old male passenger occupied the Nissan. The male in the Nissan sustained police-reported incapacitating (A-level) face/head trauma due to the air bag inflator rupture. The female driver sustained police-reported non-incapacitating (B-level) injuries to her upper extremities due to contact in the vehicle's interior.

Figure 1. Front view of the Nissan

The 2006 Nissan Sentra was a 4-door sedan with a manual restraint system consisting of three-point lap and shoulder seat belts in the five seat positions. Supplemental restraint consisted of front-seat-belt pretensioners and driver and passenger frontal air bags. A search of the NHTSA recall database www.nhtsa.gov/recall showed this vehicle had one incomplete recall: NHTSA Campaign Number 15V-287.[1] This recall was issued May 14, 2015, and involved the recall of certain Nissan vehicles with passenger frontal air bags included in the scope of the Takata air bag defect population. The safety risk stated that this inflator could be susceptible to moisture intrusion, possibly resulting in abnormal passenger frontal air bag deployment in the event of a crash, increasing the risk of injury to the occupant.

[1] https://static.nhtsa.gov/odi/rcl/2015/RCLRPT-15V287-3193.PDF

NHTSA received notification of this crash from Nissan North America in March 2021. Further research was requested, and an on-site investigation was assigned by NHTSA's Crash Investigation Division to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., in March 2021. The Nissan was inspected by SCI, the vehicle manufacturer, and technical representatives for the occupants in May 2021. Due to the pending civil litigation, the Nissan had been relocated from the Kentucky crash site and stored in Florida, where the inspection took place.

The inspection included photographic documentation and measurement of the vehicle's exterior and interior damage, identification of occupant contact points, and an evaluation of the manual and supplemental restraint systems. A detailed, non-destructive examination and disassembly of the passenger frontal air bag components was completed. Due to its age, the Nissan was not equipped with an air bag control module supported by the Bosch Crash Data Retrieval tool. A proprietary Nissan scan tool was used to access rudimentary diagnostic codes; no fault codes were stored or had been recorded. The Lexus and Chevrolet involved in the crash were not inspected.

Summary

Crash Site

The crash occurred during an afternoon in February 2021 at the four-leg intersection of two U.S. highways. The environmental conditions reported by the National Weather Service were daylight, light rain, a temperature of 3.9°C (39.0 °F), 8 percent relative humidity, and east-southeast winds at 10 km/h (6 mph). The bituminous roadway was wet.

The crash site was not inspected by SCI for this investigation due to the vehicle inspection taking place in Florida and the crash occurring in Kentucky. Detail regarding the description and layout of the intersection was obtained from internet mapping software. At the intersection, the primary trafficway was a divided five-lane roadway oriented in a general north/south direction. The northbound leg consisted of three lanes (Figure 2); two through lanes and one left-turn-only lane. The through lanes were separated by a broken white line. The left-turn-only lane was bordered by a solid white line on the right and a solid yellow line on the left. The posted speed limit was 89 km/h (55 mph).

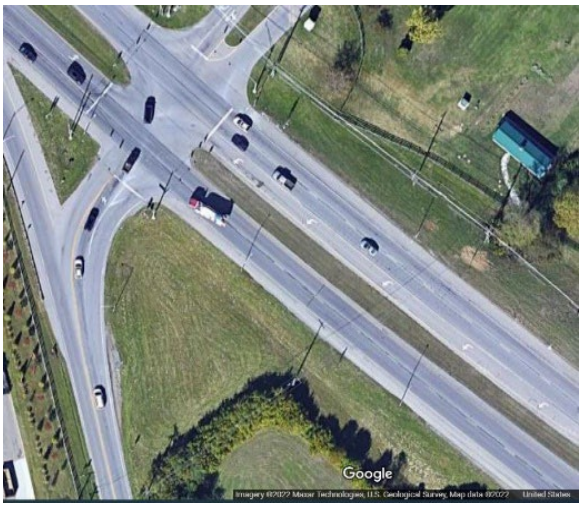


Figure 2. Google Maps © 2022 Maxar Technologies, U.S. Geological Survey Map data

Pre-Crash

The Nissan Sentra approached the intersection traveling north in the left through lane. The driver merged into the left-turn-only lane with the intention to turn left. The Lexus and Chevrolet were stopped in front of the Nissan in a line of traffic at the red traffic signal. The Nissan driver reported to the police that as she merged left and began to slow, her passenger said the traffic light was green and to "go on," according to narrative text in the police crash report (PCR). The driver reported to the police that she began to accelerate.

Crash

The front of the Nissan struck the rear of the Lexus (Event 1). The impact caused both frontal air bags in the Nissan to deploy. The driver frontal air bag deployed as intended. The passenger frontal air bag inflator ruptured during its deployment. Metal fragments were displaced into the

occupant compartment, striking the male passenger in the face and head. Hot or potentially burning inflator fragments ignited flammable materials in the passenger's floor space, resulting in a minor fire (Event 2). The Lexus was displaced forward during the initial impact and its front plane struck the rear of the Chevrolet (Event 3).

Post-Crash

All three vehicles came to rest in the left lane. Witnesses traveling behind the Nissan stopped and rendered aid. These witnesses and the Nissan driver extinguished the occupant compartment fire. The police arrived 7 minutes after the reported time of the crash. The first ambulance was reportedly on-scene 5 minutes after crash notification. Two more ambulances were called and responded to assist. The Nissan's male passenger suffered police-reported A-level injuries to his face and head. He was assisted from the Nissan and transported by ambulance to a trauma center, where he was admitted. The Nissan's driver suffered minor injuries unrelated to the passenger frontal air bag inflator rupture. She was transported by ambulance to a hospital, where she was treated and released. The 53-year-old passenger of the Lexus was transported by ambulance to a hospital with a police-reported neck injury. The drivers of the Lexus and the Chevrolet were not injured. The Nissan and Lexus were towed from the crash site due to disabling damage. The Chevrolet was driven from the scene.

2006 Nissan Sentra

Description

The 2006 Nissan Sentra 4-door sedan (Figure 3) was manufactured in August 2006 and was identified by the VIN 3N1CB51DX6Lxxxxxx. The odometer reading at the time of the inspection was 361,436 km (224,592 miles). The Nissan had the special edition trim package. The powertrain was a 1.8-liter, transverse-mounted, 4-cylinder gasoline engine linked to a 4-speed automatic transmission with front-wheel drive. Standard equipment included 4-wheel, power-assisted disc brakes with electronic brake force distribution and power steering. The gross vehicle weight rating was 1,610 kg (3,549 lb) with gross axle weight ratings of 872 kg (1,922 lb) front and 766 kg (1,688 lb) rear. At the time of the crash the Nissan had four matching Douglas All Season P205/55R16 tires. All tires had adequate tread measuring 6 mm (7/32 in) or greater. The recommended tire size for the Nissan was P195/55R16.

The interior of the Nissan had seating for five occupants with front-row bucket seats and a three-passenger, rear, split-bench seat. At the time of the vehicle inspection, the driver's seat was adjusted in a mid-to-rear track position. The seatback was reclined 20 degrees aft of vertical. The front passenger seat was adjusted mid-to-rear track position with the seatback reclined 15 degrees aft of vertical. Manual restraint was provided by 3-point lap and shoulder seat belts for the five seat positions. The front seat belts had retractor pretensioners. Supplemental restraint consisted of single-stage driver and passenger frontal air bags. The Nissan was not equipped with the optional front-seat-mounted side impact air bags.

Figure 3. Left side view of the Nissan

NHTSA Recalls and Investigations

A query of the NHTSA website www.nhtsa/recalls using the Nissan's VIN during March 2021 and again in June 2022 determined that there was one open (incomplete) recall identified by NHTSA Campaign Number 15V-287. This recall was issued May 14, 2015, and involved recall of certain Nissan vehicles equipped with passenger frontal air bags that could be susceptible to moisture intrusion, possibly resulting in abnormal passenger frontal air bag deployment in the event of a crash, increasing the risk of injury to the occupant. The recall stated that although the root cause is still under investigation, it was thought that over time the Takata SPI-type inflator body lost seal integrity that could potentially lead to ambient air penetration into the inflator. The

recall further stated that Nissan would advise vehicle owners by first class mail within 60 days. It is unknown if the Nissan's current owner was aware of the safety recall. Replacement inflators to remedy the recall became available to consumers in July 2017.

Vehicle History

The vehicle history report obtained for the Nissan reported it had five owners and one previous frontal crash (without air bag deployment). The vehicle was purchased new in August 2006 with a Georgia registration by its original owner until December 2010. At that time the Nissan was involved in a frontal crash at a mileage of 112,603 km (69,970 miles) and considered a total loss by its insurer. Owner #2 purchased the vehicle and repaired it in January 2011, registering the Nissan with a salvage title. The Nissan was sold in February 2011 and registered to Owner #3 with a rebuilt Georgia title. It passed a safety inspection in April 2011 with a reported odometer reading of 113,621 km (70,603 miles).

Owner #4 purchased the vehicle in August 2011. It was registered in Kentucky with a rebuilt title. The reported mileage at the time of this purchase was 120,718 km (75,013 miles). During this ownership, the safety recall of the passenger air bag 15V-287 was issued on May 14, 2015. This fourth ownership period continued until October 2017. The Nissan was registered annually throughout this period with several instances of routine oil/filter service and tire maintenance reported.

The fifth ownership began in October 2017 at a reported odometer reading of 239,786 km (149,000) with a rebuilt Kentucky title. Registration renewal occurred annually. The last reported service was tire maintenance in January 2021 at 358,480 km (222,755 miles). The crash occurred in February 2021 at 361,436 km (224,592 miles).

Exterior Damage

The exterior inspection of the Nissan occurred on a vehicle lift in a garage bay. The vehicle was then moved outside to facilitate the interior inspection.

The Nissan sustained impact damage isolated to the center and left aspects of its frontal plane (Figures 4 and 5). The direct damage began 17 cm (6.7 in) left of center and extended 47 cm (18.5 in) to the left front bumper corner. The Field L was 130 cm (51.2 in). The length of the direct and induced damage extended across the 152 cm (59.8 in) end width. The residual crush profile was as follows: C1 = 32 cm (12.6 in), C2 = 26 cm (10.2 in), C3 = 21 cm (8.3 in), C4 = 15 cm (5.9 in), C5 = 8 cm (3.1 in), C6 = 0. The collision deformation classification assigned to the damage pattern was 12FYEW2. There was no change in the wheelbase dimensions. All four doors remained closed during the crash and were operational at inspection. The windshield was fractured by the passenger air bag inflator rupture and had sagged onto the top of the instrument panel. There was no damage to the side windows or backlight. The severity of the impact was calculated using the "missing vehicle" algorithm of the WinSMASH program. The total delta V was 34 km/h (21 mph) with longitudinal and lateral components of -34 km/h (-21 mph) and 0. The crash configuration fit the parameters of the collision model; however, the results were considered borderline due to the use of the "missing vehicle" algorithm. The vehicle it struck was not inspected and crush measurements were not available.

Figure 4. Overhead view of the Nissan

Figure 5. Front view of the Nissan depicting the impact damage

Event Data Recorder

Due to its date of manufacture, the 2006 Nissan Sentra did not have an event data recorder (EDR) supported by the Bosch Crash Data Retrieval tool. The Nissan had a rudimentary data module that stored diagnostic fault codes. A proprietary Nissan scan tool was used by the manufacturer to access historical and current fault code data stored on the vehicle. No historical fault codes were stored. Four current fault codes were stored. These codes related to the actuation of the seat belt pretensioners and the deployment of the driver and passenger frontal air bags as a result of the crash.

Interior Damage

Interior damage to the Nissan was limited to the deployment of the driver frontal air bag, the passenger frontal air bag inflator rupture, and the minor occupant compartment fire (Event 2). There was no occupant compartment intrusion related to the exterior force of the crash. The steering wheel rim was not deformed. The glove box had separated from the instrument panel and was lying in the passenger foot well. The occupant compartment was littered with personal items and debris (Figures 6 and 7).

Figure 6. Crossing view of the Nissan's second row

Figure 7. Crossing view of the Nissan's front right passenger space

During the inspection, these materials were carefully removed beginning at the second row and moving forward in order to locate the passenger air bag components displaced during the inflator rupture. Evidence of the minor fire was observed on the center instrument panel (melted vinyl), on the debris of right floor, and on many of the removed personal items.

Manual Restraint Systems

The Nissan had continuous-loop, 3-point lap and shoulder seat belts for the five designated seat positions. The front seat belts had retractor pretensioners. The driver seat belt retracted onto an emergency locking retractor (ELR) while the other four systems used switchable ELR/automatic locking retractors (ALR). Both front row positions were equipped with adjustable D-rings each set to the lowest position.

At inspection, the driver seat belt webbing was stowed on its retractor. The retractor pretensioner had actuated; the webbing was locked and taut (Figure 8). There was no crash-related evidence of use upon examination of the latch plate or the visible portion of the webbing. This seat belt was not in use at the time of the crash. Similarly, the passenger seat belt was stowed, locked, and taut due to the actuation of the pretensioner (Figure 9). There was no indication of use upon examination. Neither occupant of the Nissan was belted at the time of the crash.

Figure 8. Photo showing the stowed and taut driver seat belt in the Nissan

Figure 9. Photo showing the stowed and taut passenger seat belt in the Nissan

Figure 10. Photo showing the Nissan's deployed driver frontal air bag

Supplemental Restraint Systems

The Nissan had driver and passenger frontal air bags that deployed at impact with the Lexus. The driver frontal air bag (Figure 10) was housed in a module located in the center of the steering wheel. The H-configuration cover flaps opened as intended and were undamaged. The driver frontal air bag measured 66 cm (26.0 in) in its deflated state. It was tethered and vented. Random post-crash blood evidence was observed on the face of the air bag fabric. There were no visible manufacturer's markings on the material related to the date of production; however, the air bag appeared to be original equipment.

Passenger Frontal Air Bag Inflator Rupture Discussion

The passenger frontal air bag module was located in the top right aspect of the instrument panel and its inflator ruptured during the deployment sequence (Figure 11). The module cover flaps opened as designed, but then separated from the top of the instrument panel (Figure 12). The flaps were found in the passenger floor area. The metal housing, surrounding the various components that comprise the inflator, had burst in a clam-shell manner (Figure 13). The separated and fragmented components were displaced rearward and struck the passenger in the face and head.

Post-crash, the housing was also located in the floor area. The auto ignition cap was located on the top of the instrument panel. The opposite end cap was lodged in the structure of the center instrument panel. The filter media fragmented during the rupture and was displaced throughout the interior. Several small fragments were found in the second row floor, between the front seats, and in the driver floor area. Large pieces of the filter were located in the front passenger footwell (Figure 14). The air bag fabric had separated from the module and was in the passenger floor area. It was holed, partially burned, and melted into an irregular shape.

The representatives for Nissan reported that the inflator appeared to be original equipment. Portions of the manufacturer's label on the inflator housing were illegible. However, the manufacturer date of 2006 by Inflation Systems, Inc., was legible in the lower right corner (Figure 15). Inflation Systems, Inc., was a supplier to and/or a component company of Takata Inc. Takata was subsequently acquired by TK Holdings Inc.

Figure 11. View into the top right instrument panel and the deformed mounting bracket for the Nissan's passenger frontal air bag module

Figure 12. Photo showing the interior side of the passenger frontal air bag cover flaps

Figure 13. Photo showing the deformed passenger frontal air bag inflator housing of the Nissan

Figure 14. View of the right front floor area of the Nissan and the location of the displaced filter media and inflator housing

Figure 15. Close-up view of the manufacturer's label on the Nissan's passenger frontal air bag inflator housing

2006 Nissan Sentra Occupant Data

Driver Demographics

Age/sex:	31 years/female
Height:	160 cm 63 in
Weight:	98 kg (215 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Mid-to-rear adjustment
Manual restraint usage:	Lap and shoulder belt available; none used
Usage source:	Vehicle inspection
Air bags:	Frontal air bag available; air bag deployed
Alcohol/drug involvement:	Not tested
Egress from vehicle:	Exited under own power
Transport from scene:	Transported to level 1 trauma center
Medical treatment:	Treated and released

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Small left third finger proximal phalanx fracture	752653.1	Isolated Front – Left instrument panel	Possible
2	Abrasion over right jaw	210202.1	Isolated Left Air Bag – Steering wheel hub	Probable

Source: emergency room report

Driver Kinematics

The 31-year-old female was seated with a presumed upright posture with the driver seat adjusted in a mid-to-rear track position. She was not belted. Based on the left offset location of the direct contact damage it was likely the driver steered to the right immediately prior to the crash as the Nissan approached the stopped traffic ahead.

The frontal air bag deployed at impact. The unbelted driver responded with a forward trajectory due to the 12 o'clock direction of the impact. She loaded the deployed driver air bag with her head and chest riding down the force of the crash. Her face contacted the air bag, possibly causing the abrasion to the right jaw. Her left hand was possibly displaced into the left instrument panel, resulting in the phalanx fracture.

Her attorney reported that she assisted in extinguishing the developing occupant compartment fire with a pillow that was in the second row. She exited the vehicle under her own power and was transported by ambulance to a trauma center, where she was treated and released.

Front-Row Right Occupant Demographics

Age/sex:	37 years/male
Height:	178 cm (70 in)
Weight:	110 kg (243 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Mid-to-rear adjustment
Manual restraint usage:	Lap and shoulder belt available; none used
Usage source:	Vehicle inspection
Air bags:	Frontal air bag available; air bag inflator rupture
Alcohol/drug involvement:	Alcohol-none; positive for opiates
Egress from vehicle:	Removed by EMS
Transport from scene:	Transported to level 1 trauma center
Medical treatment:	Hospitalized for 12 days

Front-Row Right Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Small 4 mm subdural hemorrhage in posterior falx extending into left tentorium cerebelli	140440.2	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
2	Large full-thickness avulsion laceration extending from right lower eyelid into right cheek	210804.2	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
3	Mildly displaced right inferior orbital floor and right medial orbital wall	251205.2	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
4	Comminuted displaced bilateral nasal bone fracture with large soft tissue defect of nasal bridge; degloving of nose with exposure of septum	251003.2	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
5	Multiple staples and metallic fragments in right orbit	240499.1	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
6	Large button hole in inferotemporal right conjunctiva	240416.1	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
7	2 cm laceration to anterior tip of tongue (split at mid-line, vertical orientation)	243402.1	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
8	Right supraorbital laceration; large soft tissue defect to left upper lip, 5 cm; large soft issue defect to left lower lip, 3 cm; philtral laceration, 5 cm; multiple smaller lacerations with debris over face	210602.1	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
9	Fracture of left maxillary central incisor	251404.1	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
10	Loose left mandibular lateral incisor	251402.1	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
11	Avulsion fracture of inferior anterior C2 vertebral body	650230.2	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
12	C1 hematoma without neurologic sequelae	610299.1	Isolated IPC Right Air Bag – Right top instrument panel (module rupture)	Certain
13	Partial and full-thickness burns to left anterior shin	912008.2	Isolated Non-contact Injury – Fire in vehicle	Certain
14	Left anterior thigh burn, crosses knee joint, second degree, deep partial thickness, burn 3.5%; left posterior thigh - second degree partial thickness, burn 1.5%; right anterior thigh - second degree superficial partial thickness burn; TBSA <9%	912006.1	Isolated Non-contact Injury – Fire in vehicle	Certain
15	Right thumb tuft fracture	752651.1	Isolated Front – Right instrument panel	Possible
16	Right thumb hematoma	710402.1	Isolated Front – Right instrument panel	Possible

Source: hospital records

Front-Row Right Occupant Kinematics

The 37-year-old male was seated in a presumed upright posture with the seat adjusted in a mid-to-rear track position. He was not belted. The PCR stated that he was talking to the driver, telling her the traffic light was green and to go.

The frontal air bags deployed at impact and the passenger frontal air bag inflator ruptured during deployment. As the air bag was inflating, the housing of the inflator burst open and separated from its mounted location. The filter media and components internal to the housing penetrated through the air bag fabric and struck the passenger, inflicting blunt force facial and head injuries. The entire fabric membrane of the air bag separated from the module. Potentially burning fragments were shot into the occupant compartment and ignited flammable materials in the right front area. A minor fire developed, causing burns to the passenger's bilateral thighs and left shin.

The driver and witnesses to the crash smothered and extinguished the fire with a pillow that was located in the second row. The passenger was removed from the vehicle by EMS and transported to a trauma center, where he was admitted for 12 days.

2014 Lexus CT200

Description

The Lexus was a front-wheel-drive, 5-passenger, 5-door hatchback identified by the VIN JTHKD5BH2E2xxxxxx. The vehicle had a hybrid powertrain featuring a 1.8-liter, I4 engine and 60 kw electric motor linked to an automatic transmission. Additional features included power-assisted, 4-wheel disc brakes with ABS, stability control, and traction control. Safety equipment included 3–point lap and shoulder seat belts with pretensioners for the front occupants, frontal air bags, front and rear seat-mounted side impact air bags, and inflatable curtain airbags.

The Lexus was stopped in a line of traffic when it was rear-ended by the Nissan. This impact caused a chain reaction with the Lexus displaced forward into the Chevrolet. None of the air bags in the Lexus deployed. The PCR stated the vehicle was towed from the crash site with minor damage. It was not inspected for this SCI investigation.

Occupant data

The PCR stated the Lexus was occupied by a 44-year-old belted male driver and a 43-year-old belted female passenger. The driver was not injured in the crash. The female passenger was transported by ambulance to a hospital with a police-reported non-incapacitating neck injury.

2018 Chevrolet Cruze

Description

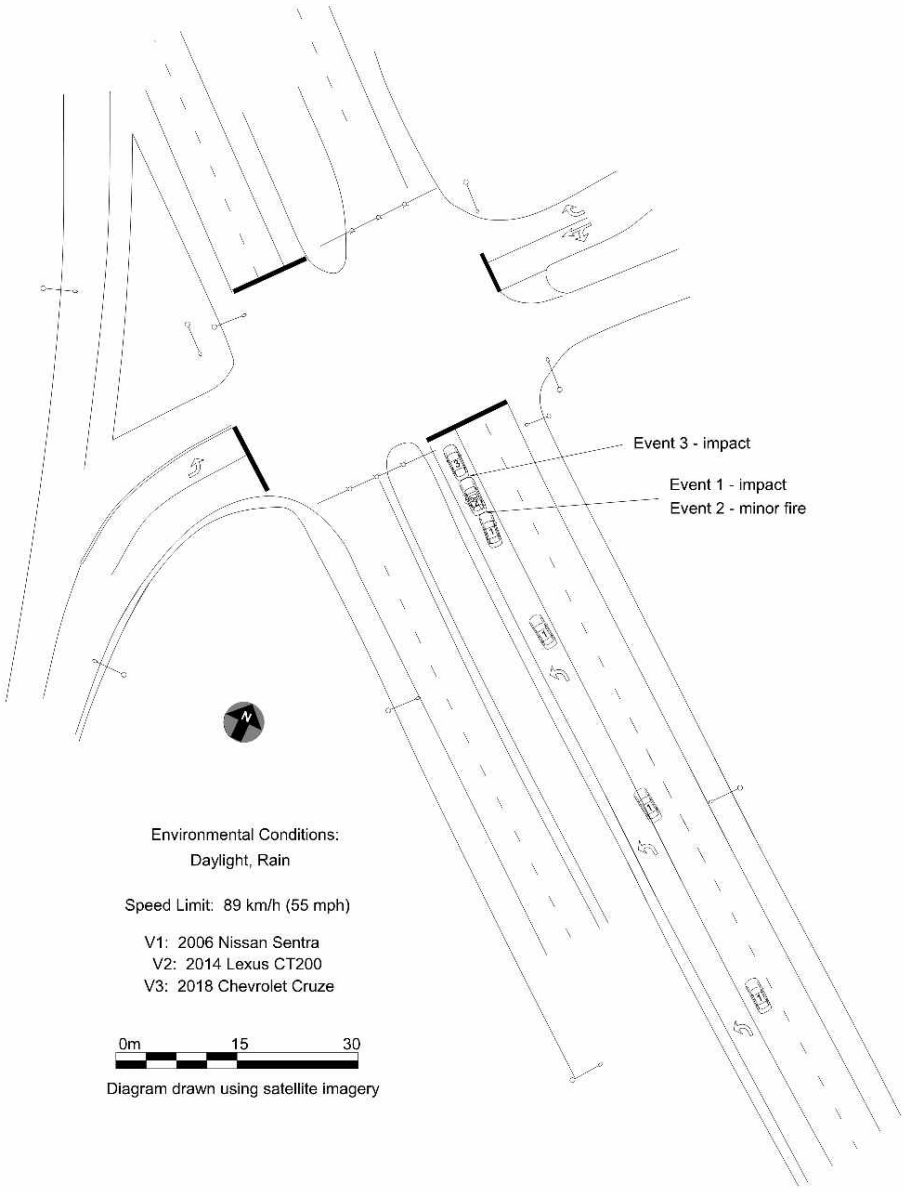
The Chevrolet was a front-wheel-drive, 5-passenger, 4-door sedan with the VIN 1G1BE5SM1J7xxxxxx powered by a 1.4-liter, 4-cylinder engine linked to 4-wheel drive, antilock brakes, electronic brakeforce distribution, and traction control. Safety equipment included 3–point lap and shoulder seat belts with pretensioners for the front occupants, frontal air bags, front seat-mounted side impact air bags, and inflatable curtain airbags.

The Chevrolet was stopped at the time of the crash, occupied by a 26-year-old belted female driver, according to the PCR. The rear of the Chevrolet was struck by the front of the displaced Lexus. The PCR stated the vehicle was driven from the scene with very minor damage. It was not inspected for the SCI investigation.

Occupant Data

The PCR stated the 26-year-old female driver was not injured in the crash.

Crash Diagram



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U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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