U.S. Department of Transportation
National Highway Traffic Safety Administration

NHTSA

DOT HS 813 715

December 2025

Special Crash Investigations:

On-Site Rollover Crash Investigation;

Vehicle: 2019 Subaru Outback Limited;

Location: North Carolina;

Crash Date: November 2022

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Suggested APA Format Citation:

Crash Research & Analysis, Inc. (2025, December). *Special Crash Investigations: On-site rollover crash investigation; Vehicle: 2019 Subaru Outback Limited; Location: North Carolina; Crash date: November 2022* (Report No. DOT HS 813 715). National Highway Traffic Safety Administration. doi.org/10.21949/0d3r-0d76

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Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
DOT HS 813 715		

4. Title and Subtitle	5. Report Date
Special Crash Investigations: On-Site Rollover System Crash Investigation; Vehicle: 2019 Subaru Outback Limited; Location: North Carolina; Crash Date: November 2022	December 2025
	6. Performing Organization Code

7. Author	8. Performing Organization Report No.
Crash Research & Analysis, Inc.	CR23001

9. Performing Organization Name and Address	10. Work Unit No. (TRAIS)
Crash Research & Analysis, Inc. P.O. Box 302 Elma, NY 14059	**11. Contract or Grant No.** 693JJ919C000004

12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
National Highway Traffic Safety Administration 1200 New Jersey Avenue SE Washington, DC 20590	Technical Report
	14. Sponsoring Agency Code

15. Supplementary Notes

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.

Digital Object Identifier: https://doi.org/10.21949/0d3r-0d76

16. Abstract

This report documents the on-site investigation of the rollover crash of a 2019 Subaru Outback Limited in North Carolina in November 2022 driven by a belted 34-year-old female with a belted 70-year-old female front passenger. The Subaru crossed into the oncoming lane, traveling more than half a mile before veering off the road, cutting through a large tree, striking a lamppost and another large tree, then rolling over. The driver sustained police-reported non-incapacitating (B-level) injuries and was hospitalized for a day. The front passenger sustained police-reported incapacitating (A-level) injuries and was hospitalized for 8 days.

17. Key Words	18. Distribution Statement
rollover, crash, investigation	Document is available to the public from the DOT, National Highway Traffic Safety Administration, National Center for Statistics and Analysis, https://crashstats.nhtsa.dot.gov.

19 Security Classif. (of this report)	20. Security Classif. (of this page)	21 No. of Pages	22. Price
Unclassified	Unclassified	48	

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Special Crash Investigations
On-Site Rollover Crash Investigation
Case Number: CR23001
Vehicle: 2019 Subaru Outback Limited
Location: North Carolina
Crash Date: November 2022

Background

This report documents the on-site investigation of the rollover crash of a 2019 Subaru Outback Limited (Figure 1) that had crash avoidance features. The National Highway Traffic Safety Administration's Crash Report Sampling System identified the crash. The police crash report was forwarded through the Police Accident Report Sampling Engine to the Special Crash Investigations (SCI) team at Crash Research & Analysis Inc. in January 2023. The on-site investigation was assigned in January 2023. The SCI team reached out to the Subaru's insurance adjustor who had possession of the vehicle. An on-site inspection took place in February 2023. The on-site activities included an inspection of the Subaru to measure exterior deformation, interior damage and intrusion, documentation of interior occupant contact, and assessment of the manual and supplemental restraint systems. The driver and front passenger were contacted for an interview but did not respond. The Subaru had an event data recorder that was imaged during the inspection process with the Bosch Crash Data Retrieval tool. The crash site was also photographed, documented, and measured by a Nikon total station.

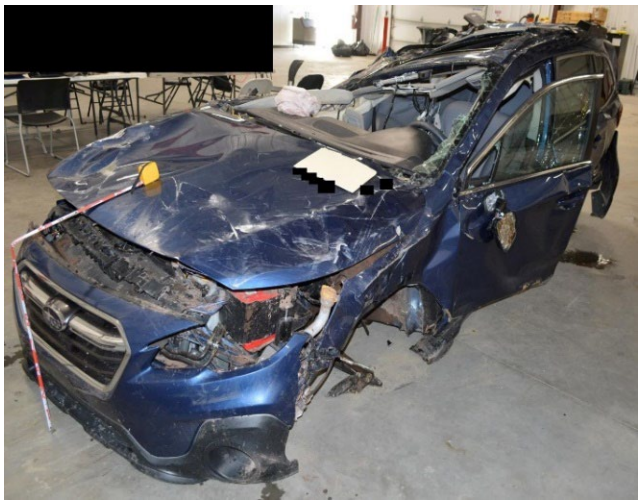

Figure 1. Left front oblique view of the Subaru

The Subaru's belted 34-year-old female driver and belted 70-year-old female front passenger were traveling on a two-lane divided parkway when the Subaru left its lane and crossed into the opposing lanes at a traffic light-controlled intersection. The Subaru continued for approximately 883 m (2,900 ft) when it veered left, striking the curb, and departing the roadway. The left rear tire rim struck and cut through a large tree. The Subaru continued, striking a lamppost and a second large tree non-horizontally with its right side. The force of the impact caused a rapid clockwise rotation of the vehicle that led to a three-quarter turn rollover with the Subaru settling back onto its roof. The driver and passenger were transported by ambulance to a Level I trauma center. The driver sustained police-reported non-incapacitating (B-level) injuries and was

hospitalized for 1 day. The front passenger sustained police-reported incapacitating (A-level) injuries and was hospitalized for 8 days. The Subaru was up-righted and towed from the scene to an insurance salvage yard where it was located for this investigation.

Crash Summary

Crash Site

The crash occurred at 1:03 p.m. on a two-lane divided parkway. At the time of the crash the National Weather Service reported environmental conditions as fair with a temperature of 19°C (67°F), 20 percent humidity, and easterly directional wind of 4.8 km/h (3 mph).

The parkway was a level, four-lane east-west roadway with a large radius left curve. The posted speed limit was 72 km/h (45 mph). There was a four-way intersection more than half a mile from the scene. The eastbound and westbound roadways each had two travel lanes separated by a raised 11.7 m (38.4 ft) wide curbed grass median with small trees planted sporadically throughout. The lanes were 4.0 m (13.1 ft) wide and separated by dashed white lane lines. The roadway's outer edges were lined with a 15 cm (5.9 in) tall by 11 cm (4.3 in) wide curb. The eastbound lanes were also lined with a concrete sidewalk that was 1.5 m (4.9 ft) wide and ran the entire roadway. After the sidewalk to the south there was a +5 percent grade grassy hill lined with trees and lampposts. The south-west section of the crash area was under construction at the time of the SCI inspection. There was a new traffic control electrical box as well as a traffic control post positioned in this area. Figures 2 and 3 show the area of the crash. A crash diagram is included at the end of this report.

Figure 2. Facing east lookback view at path of travel for the Subaru

Figure 3. Facing west trajectory view, looking at roadway departure point as indicated by the yellow cone

Pre-Crash

The Subaru was traveling west along the parkway approximately 883 m (2,900 ft) before the crash area and entered a traffic-controlled four-way intersection. According to the driver's medical history and her statements in her medical report, the driver had a history of seizures and remembers being at a traffic light. At this time, she is suspected of having had a medical episode and drove the vehicle into the opposite traffic lanes while in a catatonic state. The Subaru continued heading west in the eastbound traffic lanes. The SCI investigator was in the crash area at the approximate time of the crash and noted a medium-heavy traffic flow in both directions. It is believed the Subaru was in the right lane relative to its position. Five seconds prior to the crash

the Subaru was tracking around the left curve of the roadway at an EDR-reported speed of 105 km/h (65.2 mph). The driver steered the Subaru into the left lane and subsequently departed the left side of the roadway. Throughout the investigation, the SCI investigator made several attempts to interview the occupants, but these efforts were unsuccessful. At the time of this report, it remains unclear whether the Subaru's crash avoidance features were engaged prior to or during the crash.

Crash

The front left tire of the Subaru struck the curb (Event 1) at an EDR-reported speed of 108 km/h (67.1 mph), causing it to partially separate from the vehicle. The Subaru then ramped onto the sidewalk, striking the curb with its left rear tire (Event 2). It continued up the incline with a slight right yaw (Figure 4), where the left rear tire/rim ramped up and cut into the base of a large 40 cm (15.7 in) diameter tree (Event 3, Figure 5).

Figure 4. Facing west, viewing the initial tree impact area

Figure 5. Looking at Event 3, the first tree struck

The first tree strike caused the Subaru to roll right around its longitudinal axis onto the right tires. As it continued traveling forward, it glanced off a lamppost (Event 4, Figure 6) and struck a second large 40 cm (15.7 in) diameter tree non-horizontally along its right A and B-pillars (Event 5, Figures 7 and 8). This second tree strike caused the Subaru to rapidly rotate clockwise, where it tripped over its left rear tire and initiated a left-side-leading rollover event (Event 6, Figure 9).

Figure 6. Facing west, looking at Event 4, the struck lamppost

Figure 7. Facing west, looking at Event 5, the second tree struck

Figure 8. Facing east, viewing the lookback at the first five events

Figure 9. Facing west, viewing the trip-over point and rollover event initiation

The vehicle continued to roll three-quarters of a turn for approximately 35 m (115 ft), rotating about 180° to face northwest. The Subaru was on its roof and began rotating onto its right side when the backend struck a large 40 cm (15.7 in) diameter traffic control pole (Event 7, Figure 10). This impact interrupted the roll, and the Subaru settled back onto its roof, coming to rest approximately 73 m (240 ft) from the initial roadway departure.

Figure 10. Facing west, viewing the traffic control post and Event 7

Post-Crash

The police and EMS personnel responded to the scene after being notified by witnesses. The driver was removed from the vehicle through the driver's door with police-reported non-incapacitating injuries. The front passenger was removed from the vehicle through the second-row left door with police-reported incapacitating injuries. Both occupants were transported by ambulance to a Level I trauma center. The driver was hospitalized for 1 day before being released. The front passenger was hospitalized for 8 days before her release.

The Subaru was up-righted and towed from the scene of the crash. It was subsequently transferred to a secured insurance salvage yard where it was located for this investigation.

2019 Subaru Outback

Description

The 2019 Subaru Outback was a 4-door crossover/hatchback (Figure 11) that was manufactured in April 2019 and identified by the Vehicle Identification Number: 4S4BSANC5K3xxxxxx. The Subaru was built on a 275 cm (108 in) wheelbase and powered by a 2.5-liter, inline, 4-cylinder gasoline engine linked to automatic, continuously variable transmission with all-wheel drive. The service brakes were a power-assisted 4-wheel disc system. The steering was operated with a speed-sensitive electric rack-and-pinion system. The Subaru had an antilock braking system, electronic stability control, traction control, tire pressure monitoring system, automatic crash notification, back up camera, parking assist, rear cross traffic alert, rear automatic emergency braking, crash imminent braking, forward collision warning, dynamic brake support, pedestrian automatic emergency braking, blind spot warning, lane departure warning, lane keeping assistance, blind spot intervention, lane centering assistance, daytime running lights, and advanced lighting systems.

Figure 11. Looking down along the left side of the Subaru

The manufacturer's recommended tire size was P225/60R18 front and rear with a recommended cold tire pressure of 240 kPa (35 psi) in the front and 230 kPa (33 psi) in the rear. At the time of the SCI inspection, the Subaru had Bridgestone Dueler H/P Sport AS tires of the recommended size and mounted on original equipment manufacturer aluminum alloy wheels. All tire treads measured 6 mm (7/32 in).

The Subaru had two rows of seats for seating five occupants, two in the front and three in the rear. All seating surfaces were leather. At the time of the SCI inspection, the driver's seat was in the forward-most track position and reclined approximately 15° aft of vertical. The front passenger's seat was set between the middle and rear-most track position. The seat sustained vertical and lateral loading due to the crash events and was displaced into the center console from its at-crash position. The front seats had adjustable head restraints and used three-point lap and shoulder seat belts for manual restraint. Supplemental restraint was provided by front seat belt retractor pretensioners, frontal air bags, outboard seat-mounted side-impact air bags, seat cushion air bags, and dual sensing (side impact and rollover) roof rail inflatable curtain (IC) air

bags for both seating positions. Both the frontal, ICs and the passenger's seat-mounted air bags deployed during the crash events. The driver's seat-mounted air bag did not deploy. The deployment status of the seat cushion air bags is unknown.

Vehicle History

According to its Carfax report, the Subaru was purchased new in 2019 by the first owner and registered in North Carolina. Routine maintenance was performed at regular intervals. In November 2020 the Subaru was purchased by its second and current owner. It was registered again in North Carolina. In November 2022 the Subaru was reported to have been in a moderate-to-severe crash that is the subject of this investigation.

NHTSA Recalls and Investigations

A search of the NHTSA recall database using the Subaru's VIN at the time of assignment in January 2023 and again in March 2025 revealed no open recalls for this 2019 Subaru Outback.

Exterior Damage

The Subaru sustained major damage to the left front tire/wheel assembly (Figures 12 and 13) when it struck the left curb (Event 1). The tire was holed in several points and had separated from the rim. The rim flange had separated from the rim body due to the impact. There was overlapping damage to the left front panel and the driver's door sill from the curb strike and the rollover event. As the Subaru continued across the sidewalk, the left rear tire struck the curb causing the tire to be holed and separated from the rim (Figure 14, Event 2). The collision deformation classification[1] (CDC) assigned to Events 1 and 2 was 12FLWN3 and 12FLWN9.

[1] SAE J224_202205 – SAE Recommended Practice describing vehicle collision damage in an alphanumeric format.

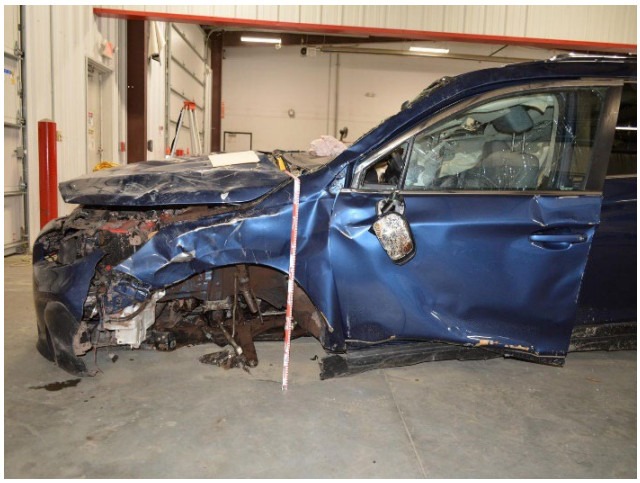

Figure 12. Damage to the left front of the Subaru from Event 1

Figure 13. Damage to the center left front wheel assembly

Figure 14. Damage to the left rear tires from Events 2 and 3

The Subaru crossed over the sidewalk and began riding up the hill and over the lower trunk of the first tree that was positioned 24.5 m (80.4 ft) from the initial curb strike and 5.2 m (17.1 ft) from the road edge. The Subaru's left side was at this point ramped up on the root system and was no longer horizonal. The left rear wheel rim struck the tree trunk and cut a deep gash into the hard wood as seen in prior Figure 5 (Event 3). The CDC assigned to this event was 10LBWN1.

The mass of the Subaru carried it non-horizontally through the impact with the first tree and into a 30 cm (11.8 in) diameter light pole striking it along the right roof rail (Event 4). The pole was positioned 31.9 m (104.7 ft) from the initial curb impact and 3.9 m (12.8 ft) from the roadway. The pole was replaced at the time of the SCI inspection, and the damage to the Subaru overlapped with the damage from the second tree impact and the rollover event damage. The CDC assigned to this event was 00RPH999.

The Subaru struck the second tree (Event 5) that was positioned 39.2 m (128.6 ft) from the initial curb impact and 5.4 m (17.7 ft) from the roadway. The force of this impact deployed the driver's and passenger's frontal left and right ICs, and front passenger's seat-mounted air bags. Due to the roll to the right, the Subaru was non-horizontal at the point of impact. The damage started 47 cm (18.5 in) forward of the vehicle's right front axle and extended rearward 332 cm (130.7 in) to the right C-pillar. The direct damage started along the top edge of the right front fender (Figure 15) and ran down the side of the vehicle across the A-pillar, B-pillar, and C-pillar. The right B-pillar received most of the force of this impact and had a partial tension separation at the top of the metal frame (Figure 16, yellow arrow). The B-pillar was crushed vertically 24 cm (9.4 in) and had a lateral component of 45 cm (17.7 in). All damage from this event overlapped with the rollover damage. There was a complete tension separation in the A-pillar 17 cm (6.7 in) from its base along the metal frame (Figure 17). Heavy abrasions ran longitudinally along the entire right side (Figure 18). The right front door was also heavily damaged in this event but due to the post-crash extrication the door damage from Event 5 is unknown. The CDC assigned to this damage pattern was 00RFHW3.

Figure 15. Damage along the right front panel from Event 5

Figure 16. Damage to the right B-pillar and roof rail with the tension tear (yellow arrow)

Figure 17. Right A-pillar separation during Event 5

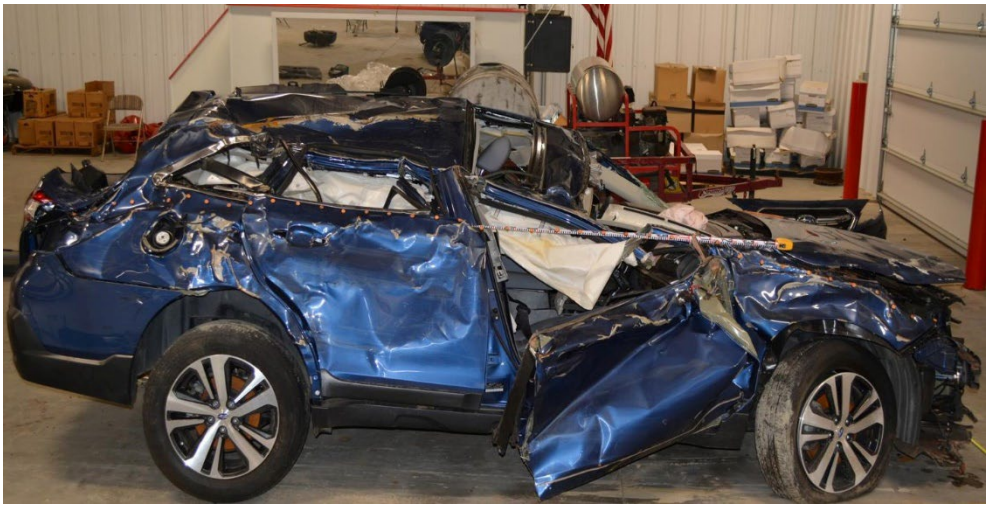

Figure 18. Overlapping damage to the right side from Events 4-6

As the Subaru separated from the tree, it began to rapidly rotate clockwise. What remained of the left side wheel rims dug into the soft earth, separating the damaged left front wheel assembly from the vehicle. This caused a left-side-leading, three-quarter-turn trip-over event (Event 6). The Subaru rolled for approximately 35 m (115 ft). The maximum crush occurred at the right A-pillar. The vertical crush component at this point was 28 cm (11.0 in) and had a lateral component of 45 cm (17.7 in). The CDC assigned to this damage was 00TDDO5.

As the Subaru rolled from its roof to the right side, its back plane struck a 40 cm (15.7 in) diameter traffic control pole (Figure 19, Event 7). The force of the impact interrupted the rollover event, and the Subaru rolled back onto its roof facing east at rest approximately 73 m (240 ft) from the initial curb impact. The CDC's assigned to this damage was 00BREN2.

Figure 19. Damage to the back of the Subaru from Event 7

Event Data Recorder

The Subaru had an air bag control module that monitored and controlled the diagnostic, sensing, and deployment commands for the vehicle's supplemental safety systems. The module had EDR capabilities. It was imaged with version 23.0.2 of the Bosch Crash Data Retrieval software through a direct-to-module imaging process by the SCI investigator. The imaged data reported with version 23.1.1 of the software is attached as an appendix at the end of this report.

The EDR was capable of storing up to two crash events, termed either non-deployment or deployment events. Non-deployment events occur when the recording trigger threshold is met or exceeded. Data from non-deployment events can be overwritten by subsequent events. Deployment events cannot be overwritten from the ACM. This ACM also categorizes non-deployment events when there is an event when non-air-bag devices, such as pretensioners, have actuated. This type of event can be overwritten given a subsequent air bag deployment event. Associative to each reported event was a 5-second pre-crash buffer. Several data points were recorded on a recurring basis of 0.5 seconds, including: vehicle speed, accelerator pedal position (% full), service brake (on/off), engine rpm, ABS activity (on/off), stability control (on, off, engaged), and steering input (degrees). A single incomplete record event was recorded by the EDR. It was determined that the data was consistent with the SCI investigation.

Record 1

The ignition cycle count at the time of the crash was 4,785 and 4,786 at the time of the download. The air bag warning lamp was off and the driver's and front passenger's seat belts were buckled. The Subaru's left front tire struck the curb (Event 1) initiating algorithm enable. The driver's frontal, passenger's frontal, front passenger's seat-mounted, and both IC air bags all deployed over 250 milliseconds into the event. The driver's seat-mounted air bag did not deploy and was recorded with an "invalid" status. The EDR did not report any retractor pretensioner activity. The maximum longitudinal delta V of this impact was -1.2 km/h (-0.7 mph) at 300 milliseconds with a lateral maximum delta V of 2.5 km/h (1.5 mph) at 250 milliseconds.

A portion of the 5-second pre-crash data of the first record is included in Table 1.

Table 1. Pre-crash data for Event 1

Time (sec) Ev.1	Vehicle Speed km/h (mph)	Engine rpm	Accelerator Pedal % Full	Service Brake (on/off)	ABS Activity	Stability Control (on/off/ engaged)	Steering wheel Angle (deg.) (+R)
-5.0	105 (65.2)	2,400	28	OFF	OFF	ON	-30.0
-4.5	105 (65.2)	2,500	32	OFF	OFF	ON	17.5
-4.0	105 (65.2)	2,500	32	OFF	OFF	ON	-20.0
-3.5	105 (65.2)	2,500	34	OFF	OFF	ON	-10.0
-3.0	106 (65.9)	2,600	33	OFF	OFF	ON	-5.0
-2.5	106 (65.9)	2,600	32	OFF	OFF	ON	-10.0
-2.0	107 (66.5)	2,600	34	OFF	OFF	ON	-10.0
-1.5	107 (66.5)	2,600	34	OFF	OFF	ON	-25.0
-1.0	107 (66.5)	2,600	33	OFF	OFF	ON	-32.5
-0.5	108 (67.1)	2,600	34	OFF	OFF	ON	-42.5
0	108 (67.1)	2,600	34	OFF	OFF	ON	-30.0

The EDR reported that 5 seconds prior to the curb impact, the vehicle was traveling at 105 km/h (65.2 mph) and continued to accelerate to 108 km/h (67.1 mph) while tracking around the curve in the roadway. Reconstruction of the crash determined that the Subaru steered left off the roadway striking the curb. The low delta V recorded by the EDR is likely underreported due to the energy absorbing properties of the wheel assembly and suspension. Further reconstruction of the crash determined that the air bags deployed during the second tree impact (Event 5) which was the highest energy loss event.

Interior Damage

There was severe interior damage (Figure 20) that consisted of several intrusions. The windshield header at the top of the right A-pillar intruded vertically 40 cm (15.7 in) and was laterally intruded 44 cm (17.3 in). The passenger A-pillar (Figure 21) also had complete tension separation 17 cm (6.7 in) from the base along the metal frame and was pushed down into the occupant space. The passenger's B-pillar (Figure 22) was vertically intruded 24 cm (9.4 in) and had a 45 cm (17.7 in) lateral intrusion component. The intruded B-pillar displaced the front

passenger's seatback approximately 20° laterally into the center console area. The front passenger's door panel came loose during the post-crash as EMS personnel attempted extrication through the right front door.

Figure 20. View of the interior damage to the front row of the Subaru

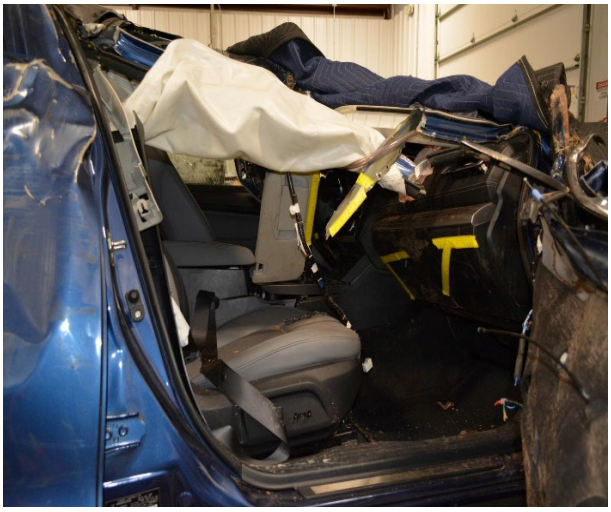

Figure 21. View of the intrusion and deployment damage to the front passenger's seat and right A-pillar area

Figure 22. View of the front row intrusion from the second row and B-pillar intrusion

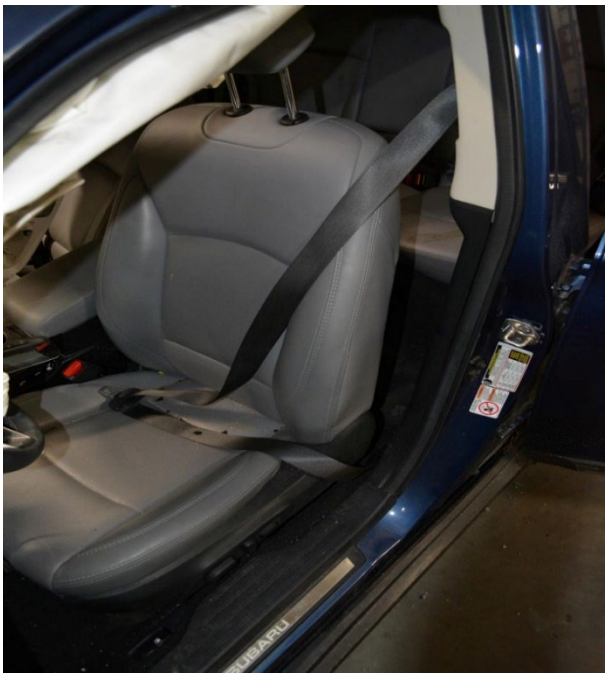

Figure 23. View of the driver's seat and seat belt

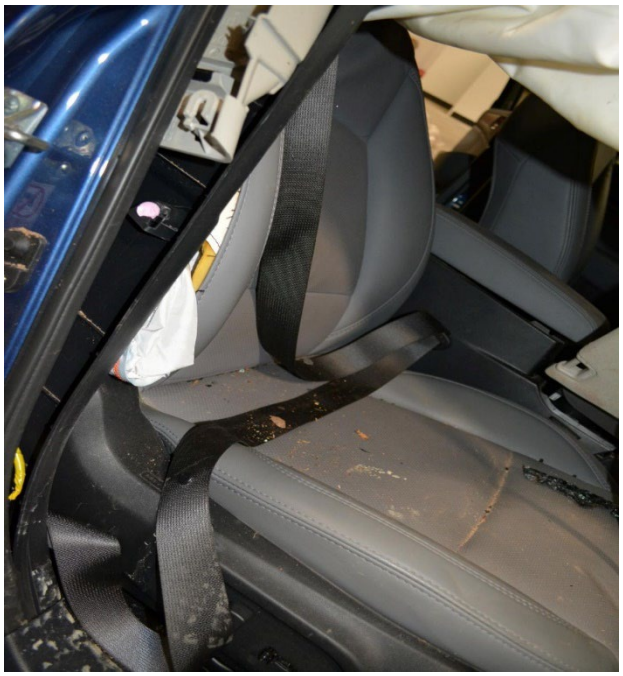

Figure 24. View of the front passenger's seat and seat belt

Manual Restraint System

The Subaru had three-point continuous loop lap and shoulder seat belts for each of the five seating positions. The front row used latch plates and adjustable D-rings and retractor pretensioners (Figure 23 and 24). The second row used latch plates and fixed D-rings.

Based on the observations of the SCI investigator, the driver and front passenger were belted at the time of the crash. The driver's and front passenger's retractor pretensioners actuated due to the crash forces and were locked. Evidence of frictional loading (abrasions) was found on the latches and webbing and supported the SCI investigator's conclusion. The EDR data also confirmed the seat belt use of both occupants.

Supplemental Restraint System

The Subaru had dual stage driver's and passenger's frontal air bags, outboard seat-mounted side-impact air bags, seat cushion air bags, and IC air bags. The driver's and passenger's frontal, front passenger's seat-mounted, and both IC air bags deployed during the crash events. It is unknown if the seat cushion air bags deployed. The driver's seat-mounted air bag did not deploy during the crash events. Malfunction of the driver's seat-mounted air bag is not suspected.

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2019 Subaru Outback Occupants

Driver Demographics

Age/sex:	34 years/female
Height:	155 cm (61 in)
Weight:	68 kg (150 lb)
Eyewear	Unknown
Seat type:	Forward-facing bucket seat with adjustable head restraint
Seat track:	Forward most seat track position
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle inspection and EDR report
Air Bags:	Frontal, seat-mounted, seat cushion, and IC air bags available; Frontal and IC deployed. Unknown if cushion air bag deployed
Alcohol/drug involvement:	None
Egress from vehicle:	Removed from vehicle due to perceived serious injuries
Transport from scene:	Ambulance to Level I trauma center
Type of medical treatment:	Hospitalized for 1 day

Driver Injuries

Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Bruising across left eye	210402.1	Isolated Left Air Bag - Steering wheel hub	Certain
2	Abrasions across left eye	210202.1	Isolated Left Air Bag - Steering wheel hub	Certain
3	Contusion to left anterior chest wall	410402.1	Isolated Interior - Shoulder portion of belt restraint	Probable
4	Bruising to posterior right shoulder	710402.1	Isolated Interior – Other Occupants (specify): Right front passenger	Possible
5	Abrasion to posterior right shoulder	710202.1	Isolated Interior – Other Occupants (specify): Right front passenger	Possible
6	Abrasion to right arm	710202.1	Isolated Interior – Other Occupants (specify): Right front passenger	Possible

Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
7	Abrasion to left arm	710202.1	Isolated Left Air Bag – Left roof side rail	Possible
8	Abrasion to right hand	710202.1	Isolated Front - Center instrument panel	Possible
9	Abrasion to left hand	710202.1	Isolated Left Air Bag – Left roof side rail	Possible
10	Bruising to right anterior hip	810402.1	Isolated Interior - Lap portion of belt restraint	Probable
11	Abrasion to right anterior hip	810202.1	Isolated Interior – Lap portion of belt restraint	Probable

Source: Hospital record

Driver Kinematics

At the time of the crash the driver was restrained by the lap and shoulder seat belt. The seat track position was found in the forward-most position, but the at-crash adjusted position is unknown. The initial impact with the curb and first tree nominally displaced her forward in her seat belt and to the left. As the Subaru disengaged from the first tree impact and was rotating to the right, the driver's upper body was displaced forward and to the right loading the shoulder and right lap portion of the seat belt. The non-horizontal impact to the right side with the second tree caused the driver to further load her shoulder belt and the right portion of her lap belt causing the injuries to her right hip. The driver was also displaced forward during this impact where her face struck the deployed driver's frontal air bag, causing injuries to her face.

The abrupt disengagement from the second tree impact and rapid clockwise rotation into the left-side-leading rollover event, displaced the driver's upper body and upper extremities first forward and to the right, then leading to the left. As the Subaru landed on its left side the driver was displaced left and into the driver's door and left side IC air bag. It is probable that during the rollover event, the front passenger's upper extremities and head contacted the driver, causing injuries to her right shoulder. The driver remained in her seat throughout the duration of the crash events and as the Subaru came to rest against the traffic control post. The driver was removed from the vehicle through the left front doorway and was transported to a Level I trauma center by ambulance. She was hospitalized for 1 day before being released.

Front-Row Right Passenger Demographics

Age/sex:	70 years/female
Height:	168 cm (66 in)
Weight:	68 kg (149 lb)
Eyewear:	Unknown
Seat type:	Forward-facing bucket seat with adjustable head restraint
Seat track position:	Between middle and rear-most
Manual restraint use:	Lap and shoulder seat belt
Usage source:	Vehicle inspection and EDR report
Air bags:	Frontal, seat-mounted, seat cushion, and IC air bags available; seat-mounted and IC deployed. Unknown if cushion air bag deployed.
Egress from vehicle:	Removed by rescue personnel
Transport from scene:	Ambulance to Level I trauma center
Type of medical treatment:	Hospitalized for 8 days

Front-Row Right Passenger Injuries

Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Flail chest unilateral, right ribs 1-5; right ribs 6-12 also fractured (non-segmental)	450212.3	Tandem IPC Primary: Right Air Bag – Right seatback outboard Secondary: Right Door Panel – Right door panel (unknown/multiple quadrant)	 Probable Certain
2	Ribs fractures: left 1-9	450203.3	Isolated IPC Interior - Center console first row	Probable
3	Left distal femur fracture, supracondylar without extension	853351.3	Isolated IPC Front – Glove compartment door	Certain
4	Moderate right pneumothorax	442202.2	Tandem IPC Primary: Right Air Bag – Right seatback outboard Secondary: Right Door Panel – Right door panel (unknown/multiple quadrant)	 Probable Certain
5	Trace left pneumothorax	442202.2	Isolated IPC Interior - Center console first row	Probable

Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
6	Mediastinal hematoma	442208.2	Isolated IPC Interior - Shoulder portion of belt restraint	Probable
7	Trace pneumomediastinum	442209.2	Isolated IPC Interior - Shoulder portion of belt restraint	Probable
8	Grade 1 spleen laceration	544222.2	Isolated IPC Interior - Center console first row	Probable
9	Left scapular body fracture	750951.2	Isolated Interior - Other seating position seatback	Probable
10	Right T2 transverse process fracture	650420.1	Isolated Roof - Roof right side rail	Possible
11	Right T3 transverse process fracture	650420.1	Isolated Roof - Roof right side rail	Possible
12	Tiny right scalp laceration overlying right parietal calvarium	110602.1	Isolated Roof - Roof right side rail	Probable
13	Right frontal scalp hematoma	110402.1	Isolated Roof - Roof right side rail	Probable
14	Left forehead abrasion	210202.1	Isolated Interior - Other occupants (specify): Driver	Possible
15	Nose abrasion	210202.1	Isolated Right Air Bag - Right top instrument panel	Probable
16	Tongue abrasion	243499.1	Isolated Interior - Same occupant contact (specify): Teeth to tongue	Probable
17	Right lower neck contusion	310402.1	Isolated Interior - Shoulder portion of belt restraint	Certain
18	Right upper chest ecchymosis	410402.1	Isolated Interior - Shoulder portion of belt restraint	probable

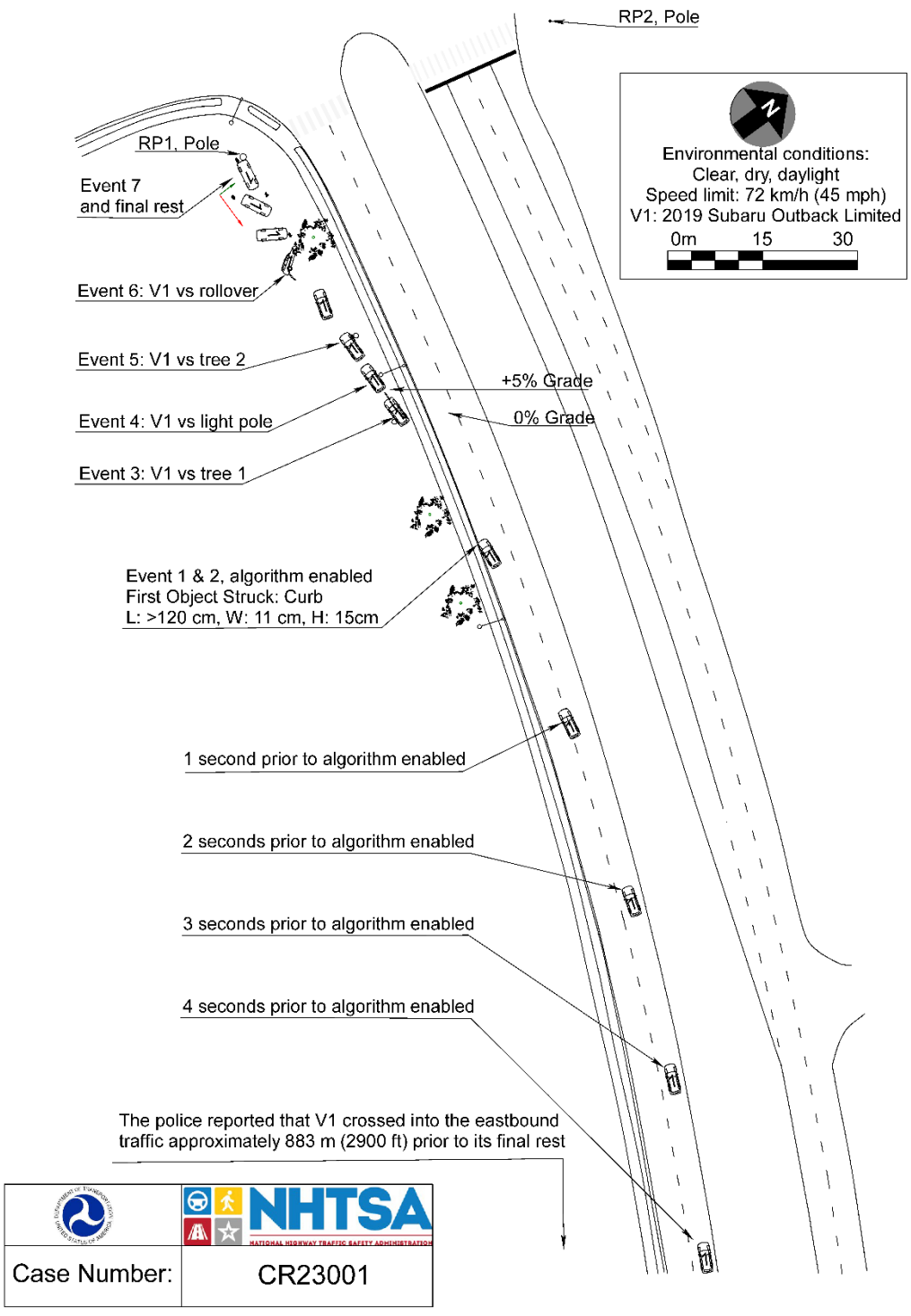
Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
19	Large abrasion to left chest wall	410202.1	Isolated Interior - Center console first row	Probable
20	Contusion to lower abdomen	510402.1	Isolated Interior - Lap portion of belt restraint	Certain
21	Lower abdomen abrasion extending to flank	510202.1	Isolated Interior - Lap portion of belt restraint	Certain
22	Left forearm abrasion	710202.1	Isolated Front - Center instrument panel	Possible
23	Right forearm abrasion	710202.1	Isolated Right Door Panel - Right forward upper quadrant	Probable
24	Right hand abrasion	710202.1	Isolated Right Door Panel - Right forward upper quadrant	Probable
25	Left hand abrasion	710202.1	Isolated Front - Center instrument panel	Possible
26	Right knee abrasion	810202.1	Isolated Front - Right lower instrument panel (includes knee bolster)	Certain
27	Right tibia abrasion	810202.1	Isolated Front - Right lower instrument panel (includes knee bolster)	Probable
28	Right ankle abrasion	810202.1	Isolated Floor - Floor (including toe pan)	Probable
29	Left ankle abrasion	810202.1	Isolated Floor - Floor (including toe pan)	Probable

Source: Hospital and EMS records

Front Row Passenger Kinematics

At the time of the crash, the front passenger was restrained by the lap and shoulder seat belt and the seat track position appeared to be set between the middle and rear-most track position. The initial impact with the curb and first tree nominally displaced her forward in her seat belt and to the left. As the Subaru disengaged from the first tree impact and was rotating to the right, the front passenger's upper body loaded the seat belt webbing and possibly the passenger's door. The non-horizontal impact to the right side with the second tree caused the front passenger to load her deploying seat-mounted and right IC air bags, and the intruding door/roof rail/roof header. The force of this impact and rapid disengagement caused the front passenger to further load the intruded components. During these events the front passenger received injuries to her lower extremities, right arm, neck, face, and right ribs. As the vehicle began to roll to the left, the front passenger's shoulder portion of the seat belt would have been loose from the right B-pillar intrusion and probably no longer restrained her upper body. The left side rollover would have caused the front passenger to load the center console, causing injuries to her spleen and left ribs as well as allowing occupant-to-occupant contact. The belted front passenger remained secure in her seat throughout the duration of the crash events and probably loaded her seatback as the Subaru came to rest against the traffic control post. She was removed from the vehicle through the second row-left door and was transported to a Level I trauma center by ambulance and hospitalized for 8 days before being released.

Crash Diagram



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Appendix A: 2019 Subaru Outback Limited Event Data Recorder Report

The EDR contained in this technical report was imaged using the current version of the Bosch CDR software at the time of the vehicle inspection. The CDR report contained in the associated Crash Viewer application may differ relative to this report.

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	4S4BSANC5K3******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CR23001 ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 23.0.2
Imaged with Software Licensed to (Company Name)	NHTSA
Reported with CDR version	Crash Data Retrieval Tool 23.1.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Record 1

Comments

No comments entered.

Data Limitations

CDR Record Information:

1. Due to limitations of the data recorded by the airbag ECU, such as the resolution, data range, sampling interval, time period of the recording, and the items recorded, the information provided by this data may not be sufficient to capture the entire crash.

2. Pre-Crash data is recorded in discrete intervals.
Due to different refresh rates within the vehicle's electronics, the data recorded may not be synchronous to each other.

3.Airbag ECU data should be used in conjunction with other physical evidence obtained from the vehicle and the surrounding circumstances.

4. If the airbags did not deploy or the pretensioners did not operate during an event that meets a specified recording threshold, it is called a Non-Deployment Event. Data from a Non-Deployment Event can be overwritten by a succeeding event that meets the specified recording threshold. If the airbag(s) deploy or the pretensioners are operated, it is called a Deployment Event.
Deployment Event data cannot be overwritten or deleted by the airbag ECU following that event.

5. If power supply to the airbag ECU is lost during an event, all or part of the data may not be recorded.

6. The Subaru Select Monitor 3 or Subaru Select Monitor 4 can be used to obtain detailed information on the diagnostic trouble codes from the airbag system , as well as diagnostic information from other systems.

General Information:

1. The airbag ECU records data for all or some of the following accident types: frontal crash, rear crash , side crash, and rollover events. Depending on the installed airbag ECU, data for side crash and/or rollover events may not be recorded.

2. This airbag ECU records data before crash and data after crash - When a single event occurs independently, the data of this event is recorded one to one.
- When multiple events occur consecutively, information on two crash events can be recorded in one storage space.

3. The airbag ECU has two spaces for recording crash data.Regarding vehicles equipped with pedestrian protection devices, there is one dedicated area for recording data of crash with pedestrians, in addition to the above two recording areas.

4. The data recorded by the airbag ECU includes correlating information between each previously occurring event (i.e., information that clarifies the collision event sequence.

5. This airbag ECU defines the point of algorithm wakeup as T0.

6. The recording trigger judgment threshold value differs depending on the collision type (i.e., frontal crash, rear crash, side crash, or rollover event).

7. Some of the data recorded by the airbag ECU is transmitted to the airbag ECU from various vehicle control modules by the vehicle's Controller Area Network (CAN).

8. In some cases, the airbag ECU part number printed on the ECU label may not match the airbag ECU part number that the CDR tool reports. The part number retrieved by the CDR tool should be considered as the official ECU part number.

9. The recording time of Delta-V, Longitudinal varies depending on the algorithm wakeup ON determination timing, and the time series data is recorded up to 250 ms.

10. The recording time of Delta-V, Lateral varies depending on the algorithm wakeup ON determination timing, and the time series data is recorded up to 250 ms.

Data Element Sign Convention:
The following table provides an explanation of the sign notation for data elements that may be included in this CDR report. Directional references to sign notation are from the perspective of the driver when seated in the vehicle facing the direction of forward vehicle travel.

Data Element Name	Positive Sign Notation Indicates
Maximum Delta-V, Longitudinal	Forward
Delta-V, Longitudinal	Forward
Maximum Delta-V, Lateral	Left to Right
Delta-V, Lateral	Left to Right
Lateral Acceleration, Side Impact Sensor [1]	Left to Right
Lateral Acceleration, Side Impact Sensor [2]	Left to Right
Lateral Acceleration, Side Impact Sensor [3]	Left to Right
Lateral Acceleration, Side Impact Sensor [4,5]	Left to Right
Roll Angle when roll over detection threshold is over [5]	Clockwise Rotation
Roll Rate	Clockwise Rotation
Steering Input	Right Turn

[1] Front Door
[2] Center Pillar
[3] Forward of Rear Wheel Apron
[4] Backward of Rear Wheel Apron
[5] If equipped

Data Definitions:
1. "Recording Status" indicates a state in which all recorded event data has been written into the non-volatile memory, or a state in which this process was interrupted and not fully written into the non-volatile memory. If "Recording Status" is "Incomplete", recorded event data may not be valid

2. "Time to Deployment Command" indicates the time between recording trigger establishment and the determination of airbag deployment. This value may differ from the actual time it takes for the airbag to fully deploy.

3."Engine RPM" indicates the number of engine revolutions, not the number of motor revolutions. The recorded value has an upper limit of 10,000 rpm. Resolution is 100 rpm and the value is rounded down and recorded. For example, if the actual engine speed is 799 rpm, the recorded value will be 700 rpm.

4. The upper limit for the recorded **"Vehicle Speed" value** is 200 km/h (125mph). Resolution is 1km/h (0.6mph) and the value is rounded down and recorded. The accuracy of the "Vehicle Speed" value can be affected by various factors. These include, but not limited, to the following.
- Significant changes in the tire•fs rolling radius
- Wheel lock and wheel slip

5. The value of the accelerator opening rate is recorded as percentage. It will increase as the driver depresses the accelerator pedal. Recording range is 0 - 100% and Resolution is 1%.

6. The shift position reverse information records information to check whether the shift position was "R" or not at the time of a crash.
- YES: "R"
- NO: other than "R"

Values recorded for AT / CVT and MT are different as shown below:

For AT / CVT: records the following, (MT) record as invalid
- No: The shift position reverse information (AT/CVT)
- Invalid: The shift position reverse information (MT)

For MT: records the following, (AT / CVT) record as invalid.
- No: The shift position reverse information (MT)
- Invalid: The shift position reverse information (AT/CVT)

7. "Passenger judgment on a passenger seat is a child?" shall use the following recording format: YES / NO

8. "Passenger information on a passenger seat" shall use the following recording format:
Empty seat, CRS / Passenger seated (AF05) / Passenger seated (AM50) / Malfunction / Invalid

9. The items to be recorded one second before time zero (T0) are as follows.
The following information does not necessarily indicate the state at the crashing moment:
- IG / ACC ON times (in case of crash)
- D / P seat belt information
- Front air bag warning light ON / OFF
- Pedestrian protection system warning light ON / OFF, if equipped
- IGN power loss information in case of crash
- D seat position (forefront or not), if equipped
- P seat position (forefront or not), if equipped
- Shift position information (reverse or not) [MT / AT · CVT]
- P seat occupant information, if equipped
- Presence of VDC communication error
- Presence of MET communication error
- Presence of CAN fail
- Presence of auto door unlocked communication error, if equipped
- Presence of EPB communication error
- Temperature sensor information, if equipped
- Outside temperature information, if equipped

10. The upper limits for the recorded value of "Motor RPM" is10,000 rpm. Resolution is 100 rpm and the value is rounded down and recorded.

11. The upper and lower limits for the recorded value of "Steering Input" is 250 deg and -250 deg respectively. Resolution is 1.5 deg and the value is rounded down and recorded.

12. "Delta-V, Longitudinal" indicates the change in forward speed after time zero. This does not refer to vehicle speed, and it does not include the change in speed during the period from the start of the actual collision to establishment of the time zero.

13. "Roll Angle at the Time of TRG" do not represent the actual roll angle of the vehicle. These values are used internally by the airbag ECU for sensing a rollover.

14. "Multi-event time number" indicates whether multiple crash occurred or not (two or more crashes within 5 s).
- 1: first time
- 2: second time
- The upper limit of the value to be recorded is 65,534 times.

15. "Time from the previous event" indicates the time from a recording TRG formation of the previous crash event to a recording TRG formation of the latest crash event. Upper limit of the recording value is 5000 ms.

22001_DL001_r003

System Status at Retrieval

ROMID	93 12 26 03 00
ACM Part Number	98221AL26B
Event Record 1	Recorded
Event Record 2	Not Recorded
Event Record 3	Not Recorded

System Status at Event (Record 1)

Ignition Cycle, Download (cycles)	4,786
Complete File Recorded (Yes, No)	No
Multi-Event, Number of Events (1, 2)	1
Recording order information	1
Time from Event 1 to 2 (sec)	-
Maximum Delta-V, Longitudinal (MPH [km/h])	-1.2 [-2]
Time, Maximum Delta-V, Longitudinal (ms)	300.0
Maximum Delta-V, Lateral (MPH [km/h])	2.5 [4]
Time, Maximum Delta-V, Lateral (ms)	250.0
Sensor Design Range Exceeded time, Longitudinal Acceleration (ms)	invalid
Sensor Design Range Exceeded time, Lateral Acceleration (ms)	invalid
Roll angle, Rollover Deployment (deg)	invalid

Deployment Command Data (Record 1)

Frontal Airbag Deployment, Time to First Stage Deployment, Driver (ms)	More than 250 ms
Frontal Airbag Deployment, 1st Stage, Driver	Yes
Frontal Airbag Deployment, Time to 2nd Stage Deployment, Driver (ms)	More than 250 ms
Frontal Airbag Deployment, 2nd Stage, Driver	Yes
Frontal Airbag Deployment, Time to 2nd Stage, Passenger (ms)	More than 250 ms
Side Airbag Deployment, Time to Deploy, Driver (ms)	invalid
Side Airbag Deployment, Time to Deploy, Passenger (ms)	More than 250 ms
Side Curtain/Tube Airbag Deployment, Time to Deploy, Driver Side (ms)	More than 250 ms
Side Curtain/Tube Airbag Deployment, Time to Deploy, Passenger (ms)	More than 250 ms
Frontal Airbag Deployment, Time to Deploy, Passenger (ms)	More than 250 ms

Pre-Crash Data -1 Sec (Record 1)

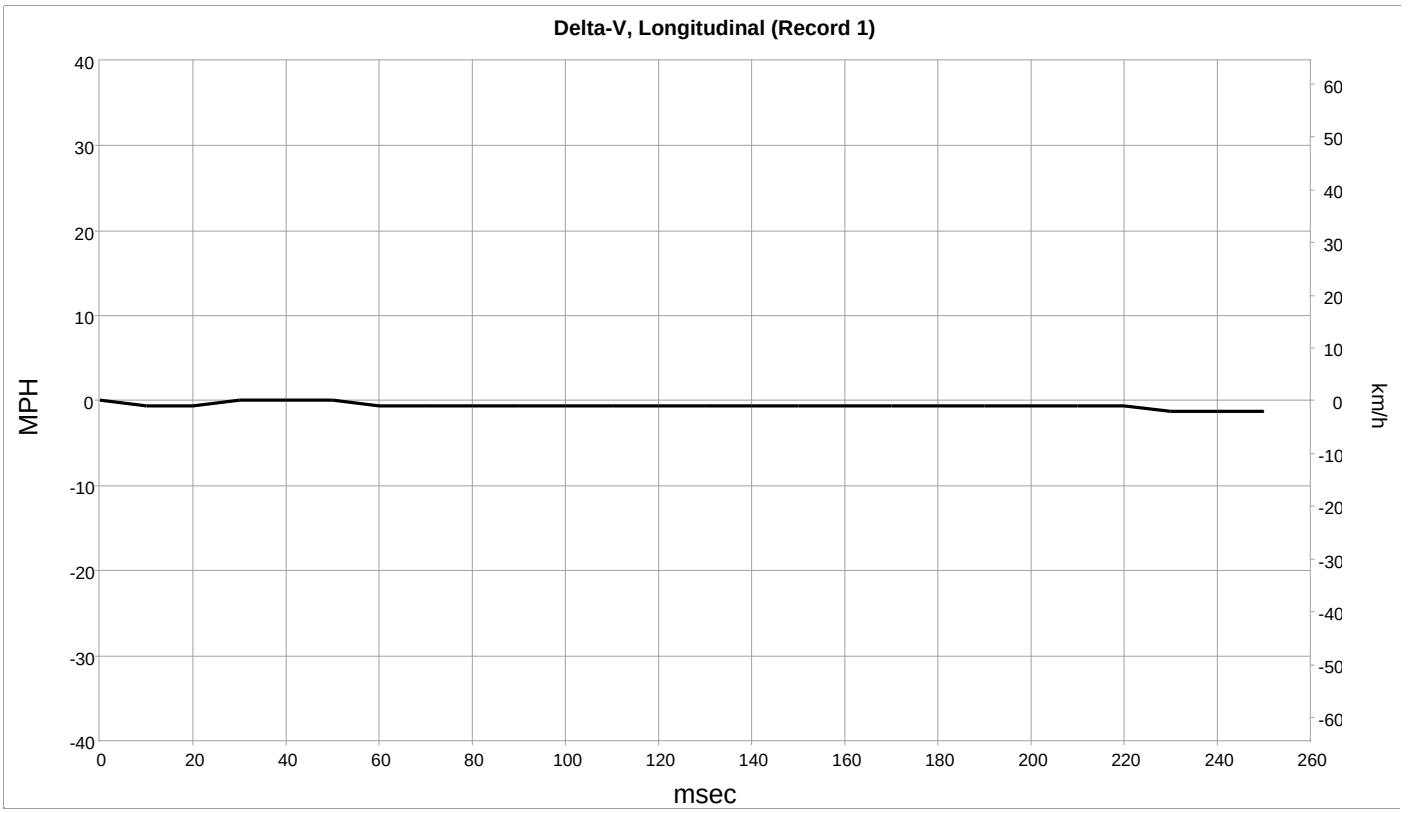
Ignition Cycle, Crash (cycles)	4,785
Safety Belt Status, Driver	buckled
Frontal Airbag Warning Lamp, On/Off	OFF
Safety Belt Status, Passenger	buckled
Occupant Information, Passenger	Invalid
Shift position information (reverse or not)	Invalid
MT reverse SW (reverse or not)	Invalid

Pre-Crash Data -5 to 0 Sec (Record 1 (Table 1 of 1))

Time (sec)	-5.0	-4.5	-4.0	-3.5	-3.0	-2.5	-2.0	-1.5	-1.0	-0.5	0.0
Speed, Vehicle Indicated (MPH [km/h])	65.2 [105]	65.2 [105]	65.2 [105]	65.2 [105]	65.9 [106]	65.9 [106]	66.5 [107]	66.5 [107]	66.5 [107]	67.1 [108]	67.1 [108]
Accelerator Pedal, % Full (%)	28	32	32	34	33	32	34	34	33	34	34
Service Brake, On/Off	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Engine RPM (RPM)	2,400	2,500	2,500	2,500	2,600	2,600	2,600	2,600	2,600	2,600	2,600
ABS Activity	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF	OFF
Stability Control (On, Off, Engaged)	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON	ON
Steering Input (deg)	-30.0	17.5	-20.0	-10.0	-5.0	-10.0	-10.0	-25.0	-32.5	-42.5	-30.0

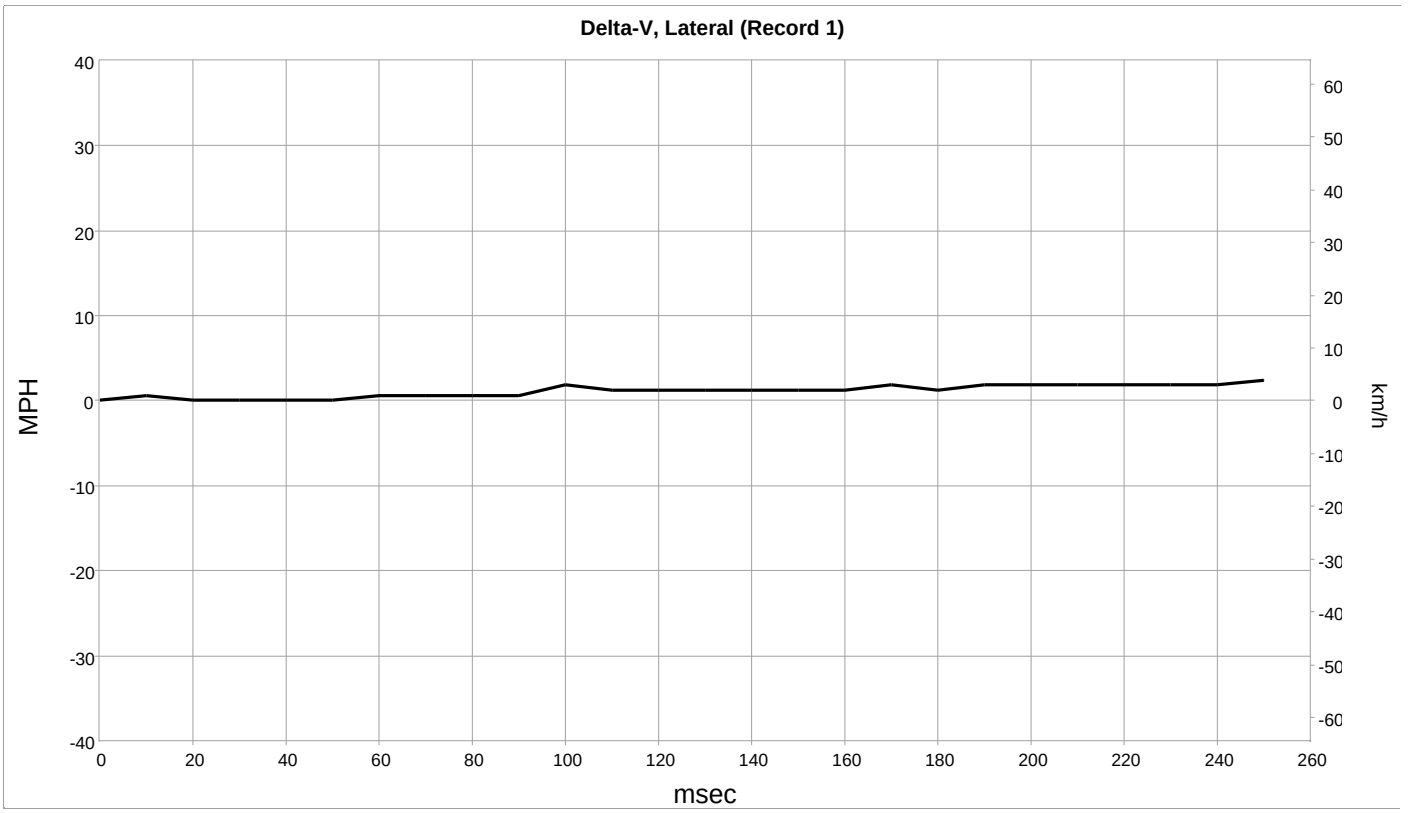
Longitudinal Crash Pulse (Record 1)

Time (msec)	Delta-V, Longitudinal (MPH [km/h])
0	0.0 [0]
10	-0.6 [-1]
20	-0.6 [-1]
30	0.0 [0]
40	0.0 [0]
50	0.0 [0]
60	-0.6 [-1]
70	-0.6 [-1]
80	-0.6 [-1]
90	-0.6 [-1]
100	-0.6 [-1]
110	-0.6 [-1]
120	-0.6 [-1]
130	-0.6 [-1]
140	-0.6 [-1]
150	-0.6 [-1]
160	-0.6 [-1]
170	-0.6 [-1]
180	-0.6 [-1]
190	-0.6 [-1]
200	-0.6 [-1]
210	-0.6 [-1]
220	-0.6 [-1]
230	-1.2 [-2]
240	-1.2 [-2]
250	-1.2 [-2]



Lateral Crash Pulse (Record 1)

Time (msec)	Delta-V, Lateral (MPH [km/h])
0	0.0 [0]
10	0.6 [1]
20	0.0 [0]
30	0.0 [0]
40	0.0 [0]
50	0.0 [0]
60	0.6 [1]
70	0.6 [1]
80	0.6 [1]
90	0.6 [1]
100	1.9 [3]
110	1.2 [2]
120	1.2 [2]
130	1.2 [2]
140	1.2 [2]
150	1.2 [2]
160	1.2 [2]
170	1.9 [3]
180	1.2 [2]
190	1.9 [3]
200	1.9 [3]
210	1.9 [3]
220	1.9 [3]
230	1.9 [3]
240	1.9 [3]
250	2.5 [4]



Hexadecimal Data

Data that the vehicle manufacturer has specified for data retrieval is shown in the hexadecimal data section of the CDR report. The hexadecimal data section of the CDR report may contain data that is not translated by the CDR program. The control module contains additional data that is not retrievable by the CDR system.

```
62 10 00 3E 80 00 05
62 10 20 F7 86 00 01
62 10 40 07 80 00 01
62 10 60 04 00 00 01
62 10 66 80
62 23 00 C0 01 EE 01
62 23 01 00 FF FF 00 00 00 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FE FE FE
62 23 02 00 01 00 00 00 00 01 01 01 01 03 02 02 02 02 02 02 03 02 03 03 03 03 03 03 04
62 23 10 69 69 69 69 6A 6A 6B 6B 6B 6C 6C
62 23 11 1C 20 20 22 21 20 22 22 21 22 22
62 23 12 00 00 00 00 00 00 00 00 00 00 00
62 23 13 18 19 19 19 1A 1A 1A 1A 1A 1A 1A
62 23 15 00 00 00 00 00 00 00 00 00 00 00
62 23 16 00 00 00 00 00 00 00 00 00 00 00
62 23 17 F4 07 F8 FC FE FC FC F6 F3 EF F4
62 23 20 F7 F8 73 7F
62 23 21 FE
62 23 22 78
62 23 23 04
62 23 24 64
62 23 26 FB
62 23 27 FB
62 23 28 FB
62 23 29 FB
62 23 2A FF
62 23 2B FB
62 23 2C FB
62 23 2D FB
62 23 32 00
62 23 33 00
```

62 23 34 00

62 23 37 FF

62 23 38 FF

62 23 3A 80

62 23 3D 03

62 23 3E 03

62 23 3F 03

62 23 40 F8 7F E6 41

62 23 41 12 B1

62 23 42 12 B2

62 23 43 FF

62 23 44 FF

62 23 45 55

62 23 56 00 01

62 23 57 AA

62 23 60 C0 01 EE 01

62 23 61 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

62 23 62 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00

62 23 70 FF FF FF FF FF FF FF FF FF FF FF

62 23 71 FF FF FF FF FF FF FF FF FF FF FF

62 23 72 03 03 03 03 03 03 03 03 03 03 03

62 23 73 FF FF FF FF FF FF FF FF FF FF FF

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62 23 83 00

62 23 84 FF

62 23 86 FF

62 23 87 FF

62 23 88 FF

62 23 89 FF

62 23 8A FF

62 23 8B FF

62 23 8C FF

62 23 8D FF

62 23 92 00

62 23 93 03

62 23 94 03

62 23 97 FF

62 23 98 FF

62 23 9A 80

62 23 9D 03

62 23 9E 03

62 23 9F 03

62 23 A0 F8 7F E6 40

62 23 A1 FF FF

62 23 A2 12 B2

62 23 A3 FF

62 23 A4 FF

62 23 A5 FF

62 23 B6 00 00

62 23 B7 FF

62 F1 82 93 12 26 03 00

62 F1 8E 39 38 32 32 31 41 4C 32 36 42

Disclaimer of Liability

The users of the CDR product and reviewers of the CDR reports and exported data shall ensure that data and information supplied is applicable to the vehicle, vehicle's system(s) and the vehicle ECU. Robert Bosch LLC and all its directors, officers, employees and members shall not be liable for damages arising out of or related to incorrect, incomplete or misinterpreted software and/or data. Robert Bosch LLC expressly excludes all liability for incidental, consequential, special or punitive damages arising from or related to the CDR data, CDR software or use thereof.

DOT HS 813 715
December 2025

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

16657-120225-v3b