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Special Crash Investigations: On-Site Alleged Driver Air Bag Fatality Crash Investigation; Vehicle: 2009 Saturn Aura; Location: Indiana; Crash Date: January 2020

DISCLAIMER

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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 on-site investigation of the frontal crash of a 2009 Saturn Aura into the concrete base of a light pole, the injuries sustained by the belted 28-year-old female driver, and the alleged involvement of the vehicle's driver frontal air bag. The crash occurred in a shopping center parking lot at night. The Saturn was traveling through the parking lot when the front plane/left and center aspects struck the concrete base, resulting in deployment of the driver's frontal air bag. The crash resulted in a severe injury to the driver, who expired 5 days after the crash. The injured driver was initially transported by private conveyance to a fire station, where she received initial treatment including CPR. She was then transported by ambulance to a hospital and expired 5 days after the crash.

Through the course of the SCI investigation, it was determined that the belted driver was holding and using a cell phone and was most likely seated out-of-position, forward with her head turned to the left. During the crash, the cell phone became captured between the steering wheel rim and her anterior neck as the driver responded to frontal crash forces. Prior to the air bag deployment, the driver's neck contacted the edge of the cell phone, causing a fracture of the thyroid cartilage and a laceration of the pharynx, which compromised her airway. The driver's neck injuries were related to the force of the crash, not to the deployment of the driver frontal air bag.

17. Key Words	18. Distribution Statement
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Special Crash Investigations
On-Site Alleged Driver Air Bag Fatality Crash Investigation
SCI Case No: CR20014
Vehicle: 2009 Saturn Aura
Location: Indiana
Crash Date: January 2020

Background

This report documents the on-site investigation of the frontal crash of a 2009 Saturn Aura (Figure 1) into the concrete base of a light pole, the injuries sustained by the belted 28-year-old female driver, and the alleged involvement of the vehicle's driver frontal air bag. The crash resulted in severe injury to the driver, who was removed from life support after 5 days without recovery.

Figure 1. 2009 Saturn Aura

The Saturn was equipped with Certified Advanced 208-Compliant frontal air bags, front-seat-mounted side impact air bags, inflatable curtain (IC) air bags and front-row seat belt retractor pretensioners. The pretensioners actuated and the driver's frontal air bag deployed as a result of the crash. The crash occurred in January 2020 and was investigated by a local police agency. This police agency notified the National Highway Traffic Safety Administration of the crash in March 2020 and an investigation was assigned to the Special Crash Investigations team at Crash Research and Analysis, Inc. The SCI team contacted the investigating police agency and established cooperation to inspect the vehicle, which was being held in the police impound. Due to COVID-19 pandemic travel restrictions, the on-site portion of the investigation was delayed. In May 2020 the SCI investigator met with law enforcement investigators and conducted the vehicle and scene inspections.

The SCI on-site investigation consisted of inspection of the Saturn to measure its exterior and interior damage, assessment of the manual and supplemental restraint systems, and identification of points of occupant contact. Further attention was paid to the steering assembly, frontal air bag, and seat belt system. The Saturn was equipped with an event data recorder (EDR) that was supported by the Bosch Crash Data Retrieval tool and was imaged by the SCI investigator. The crash site was photographed and mapped by the Nikon total station during the SCI inspection.

The crash occurred in a shopping center parking lot. The Saturn, a 4-door sedan occupied by a belted driver, was traveling in a northwest direction through the parking lot when the left and center aspect of the vehicle's front plane struck the concrete base of a light pole. At the time of

the crash, the driver was holding and using a cell phone and probably seated out-of-position, forward with her head turned to the left. Through the course of the investigation, it was determined that the cell phone most likely became captured between the steering wheel rim and her anterior neck as the driver responded to the frontal crash forces, prior to air bag deployment. Her neck contacted the edge of the cell phone, causing a fracture of the thyroid cartilage and a pharynx laceration, which compromised her airway. According to the hospital and autopsy records, the driver's neck injuries contributing to her death were related to injuries caused by the cell phone, not to the deployment of the vehicle's driver's frontal air bag.

Crash Summary

Crash Site

This crash occurred at night under artificial lighting in heavy rain with south winds at 10 km/h (6 mph) and a temperature of 12 °C (53 °F), according to local weather reports. The parking lot was a large, open, level area surfaced with bituminous asphalt. At the time of the crash the surface was wet. Pavement marking consisted of painted lines delineating parking spaces. The lot was illuminated by several light poles mounted to large diameter concrete bases. A crash diagram is included at the end of this report.

Pre-Crash

The police investigation determined that the driver of the Saturn drove northwestward through the parking lot (Figure 2) and was intending to meet an acquaintance who was parked near the fuel pumps in the northern part of the same lot. The Saturn traveled through the parking lot at EDR-recorded speeds ranging from 19 to 31 km/h (12 to 19 mph). The driver was steering to the right and the vehicle traversed a clockwise arcing trajectory (Figure 2). EDR data indicated she applied the brakes 2.0 seconds prior to algorithm enable (AE). One second prior to AE, the vehicle was traveling 29 km/h (18 mph).

Figure 2. Northwest view of the Saturn's estimated approach to the point of impact

Cell phone data acquired by the police investigation indicated the driver had short phone calls and texts with several people and with the acquaintance she was meeting. The overlapping time stamps between the calls and texts indicated that she probably was using the speakerphone function during the operation/manipulation of the cell phone. The communications with the acquaintance indicated she was having difficulty determining his location.

Crash

The front plane, left and center aspects of the Saturn struck the concrete base of the light pole (Figure 3), which measured 63 cm (24.8 in) in diameter. The direction of force was in the vehicle's 12 o'clock sector. The driver's frontal air bag deployed and both front-row seat belt retractor pretensioners actuated. The Saturn crushed and then rebounded, coming to final rest approximately 46 cm (18.1 in) south of the concrete base (Figure 4).

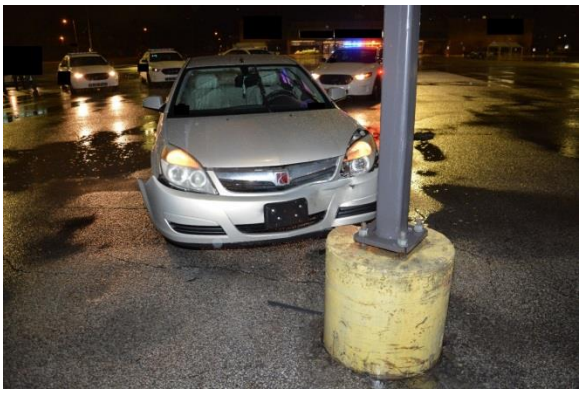


Figure 3. South-facing on-scene police image of the Saturn and the struck concrete base of the light pole

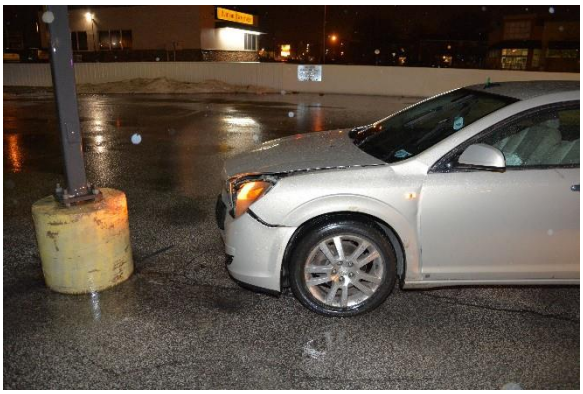


Figure 4. East-facing on-scene police image of the Saturn at final rest

Post-Crash

The driver's acquaintance, who was inside his vehicle parked north of the crash site, saw the crash. He immediately drove to the site and parked alongside the Saturn. In his first statement, given on the night of the crash, he told police that the Saturn driver got out of her vehicle under her own power after the crash and he assisted her into the passenger seat of his car. He further stated that en route to the hospital, she said she couldn't breathe, spit up blood, and passed out. Later, in statements given in January and February 2020, the acquaintance stated he helped the Saturn driver out of her car and into the passenger seat of his vehicle. The acquaintance then returned to the Saturn to turn off the engine and retrieve her cell phone. While doing this, she exited his vehicle and proceeded to try and get into the driver's seat of his vehicle. He put her back into the front passenger seat and proceeded toward a hospital. During transport to the nearest hospital, he noticed she started gasping and saying that she was having a hard time breathing.

As he noticed the Saturn driver was in medical distress, he drove into the parking lot of a fire station located approximately 300 m (984 ft) from the crash site and requested medical assistance. The police were notified and arrived at the fire station within 4 minutes. Fire department personnel performed CPR on the Saturn driver and intubated her. She was transported by ambulance to the emergency room of a local hospital, where she was admitted. After 5 days without signs of recovery, the driver was removed from life support and expired.

2009 Saturn Aura

Description

The Saturn was a front-wheel drive, 5-passenger, 4-door sedan with the Vehicle Identification Number 1G8ZV57B99Fxxxxxx that was powered by a 2.4 liter, 4-cylinder engine linked to a 6-speed automatic transmission with 4-wheel antilock brakes, electronic brakeforce distribution, and traction control. The wheelbase was 285 cm (112.2 in) and the curb weight was 1,654 kg (3,522 lb). The information placard stated the vehicle's gross vehicle weight rating was 1,999 kg (4,406 lb) with gross axle weight ratings of 1,049 kg (2,313) front and 949 kg (2,093 lb) rear. The vehicle manufacturer's recommended tire size was P215/55R17. The vehicle was equipped with a Firestone FR740 tire on the left front wheel, a Milestar MS932 Sport tire on the left rear wheel, a Hankook Optimo H426 tire on the right rear wheel, and a Primewell Valera Touring tire on the right front wheel. All tires were of the recommended size and in marginal to poor condition, with 3 mm (4/32 in) of tread depth or less.

The front row was equipped with leather-upholstered bucket seats with adjustable head restraints. The driver's seat track was adjusted to a middle position (Figure 5) and the bottom of the driver's head restraint was 5 cm (2.0 in) above the top of the seatback.

Figure 5. Front row of the Saturn. Note: seat track position for driver. (On-scene police image)

Exterior Damage

The Saturn sustained direct contact damage to the left and center aspects of the front plane from impact with the concrete base of the light pole (Figure 6). The bumper beam, bumper fascia, grille, left head and turn light assemblies, and hood were directly damaged. The direct contact started 21 cm (8.3 in) left of the centerline and extended 40 cm (15.7 in) left. The crush measurements were documented on the front bumper beam and the Field L was 104 cm (40.9 in). For demonstrative purposes, the magnets across the hood of the Saturn in Figure 6 represent the approximate location of the deformed bumper beam. The residual crush values were C1 = 28 cm (11.0 in), C2 = 23 cm (9.1 in), C3 = 16 cm (6.3 in), C4 = 9 cm (3.5 in), C5 = 5 cm (2.0 in), C6 = 0 cm. The maximum residual crush was 28 cm (11.0 in) and was located 49 cm (19.3 in) left of center.

Figure 6. Front plane damage to the Saturn

The barrier algorithm of the WinSMASH program was used to calculate the severity of the crash. The Saturn's total delta V was 29 km /h (18.0 mph). The longitudinal and lateral velocity changes were -29 km/h (-18 mph) and 0 km/h, respectively. The results appear reasonable. The EDR-recorded longitudinal delta V was -28.3 km/h (-17.6 mph). The Collision Deformation Classification for the front plane impact was 12FYEN2 (0 degrees).

Event Data Recorder

The Saturn's EDR was imaged with version 19.4 and reported with version 21.0.1 of the Bosch Crash Data Retrieval software. The data in the sensing diagnostic module was imaged via direct connection to the Saturn's diagnostic link connector. This EDR was capable of recording both deployment and non-deployment events and had the capacity to store two deployments and one non-deployment event. One deployment event was recorded. The EDR report is attached at the end of this report as Appendix A.

System Status at Deployment: This deployment event was recorded during the Saturn's front plane impact with the concrete base of the light pole. The driver's seat belt was reported as "Buckled" and the air bag warning lamp status was "Off." The maximum longitudinal and lateral delta-Vs in the tabular data of the EDR report were -28.4 km/h (-17.62 mph) at 140 msec and -2.2 km/h (-1.36 mph) at 110 msec after AE, respectively. The driver's frontal air bag stage 1 met deployment command criteria at 54 msec. Stage 2 underwent disposal at 156 msec. Of particular note, the recorded longitudinal velocity change experienced by the vehicle and occupant at the time of the air bag deployment was -15.3 km/h (-9.5 mph).

The EDR recorded 5 seconds of pre-crash data. The Saturn's EDR-reported speed, engine RPM, percent throttle, brake switch circuit status, accelerator pedal percent, antilock brake system active, yaw rate, and steering angle are presented in the table below.

Parameter	**-5 sec**	**-4 sec**	**-3 sec**	**-2 sec**	**-1 sec**
Vehicle Speed km/h (mph)	19 (12)	26 (16)	31 (19)	31 (19)	29 (18)
Engine Speed (rpm)	1984	2240	2176	1408	1280
Percent Throttle	44	45	34	26	25
Brake Switch Circuit State	OFF	OFF	OFF	ON	ON
Accelerator Pedal Position (Percent)	29	29	11	0	0
Antilock Brake System Active	No	No	No	No	No
Yaw Rate	-1	4	3	2	0
Steering Wheel Angle (Degrees)	16	48	32	32	32

Interior Damage

The interior of the Saturn did not sustain any damage or intrusion to the occupant compartment during the frontal impact to the concrete base of the light pole. No window was contacted or damaged and all doors remained closed and operational. Based on police images, the steering wheel was turned to approximately 30 degrees to the left at final rest (Figure 7). At the time of the SCI inspection, the steering wheel was turned 90 degrees to the left [refer to Figure 10 page 7 below]. At inspection, the steering wheel flange was deformed and the left side of the steering wheel rim was displaced forward approximately 2 mm (0.1 in) from driver loading (Figure 8). The combination of driver loading and air bag deployment against the forward-positioned driver compressed the energy absorbing steering column, evidenced by shear capsule separation estimated at less than 6 mm (0.25 in).

Manual Restraint Systems

The Saturn was equipped with manual 3-point lap and shoulder seat belts for the five occupant positions. The driver's seat belt system consisted of continuous loop webbing that retracted onto an emergency locking retractor (ELR) with a sliding latch plate. The D-ring was adjusted to the full-down position. The EDR reported that the retractor pretensioner actuated. At inspection, the retractor was not locked. The belt webbing could be extended and retracted; however, did not operate smoothly. The driver was restrained by her lap and shoulder seat belt as evidenced by load marks on the seat belt and D- ring (Figure 9). A 6 cm (2.4 in) load mark on the belt webbing from contact to the D-ring was located 168 cm (66.1 in) from the seat frame left anchor point. Additionally, subtle load marks were also noted on both sides of the latch plate belt guide.

Figure 7. Disparity in gap between Saturn's steering wheel hub and column.
Note: wheel was rotated 90 degrees to the left at the time of the SCI inspection

Figure 8. On-scene police image of the Saturn's interior. The steering wheel is rotated an estimated 30 degrees to the left (counter-clockwise)

Figure 9. The Saturn driver's seat belt evidence

Supplemental Restraint Systems

The Saturn was equipped with CAC/dual-stage frontal air bags, front-seat-mounted side impact air bags, and IC air bags. The driver's frontal air bag deployed in this crash.

The driver's frontal air bag (Figure 10) was located in the steering wheel hub. The air bag measured 52 cm (20.5 in) in diameter in its deflated state. There was minor scuffing located at the 12'clock sector of the air bag. Note that the steering wheel is turned 90-degrees to the left in the figure. The module cover was a two-flap configuration made of semi-rigid vinyl, with a vertical tear seam in the center. The flaps were 5 cm (2.0 in) wide and 14 cm (5.5 in) in height. The cover flaps opened at the designated tear seam and were undamaged.

Figure 10. Driver's frontal air bag of the Saturn

Saturn Aura Occupant Data

Driver Demographics

Age/sex:	28 years old/female
Height:	157 cm (62 in)
Weight:	67 kg (148 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Middle
Manual restraint usage:	Lap and shoulder seat belt
Usage source:	Vehicle inspection, EDR, police crash report
Air bags:	Frontal, seat-mounted side impact and IC air bags available; frontal deployed
Alcohol/drug involvement:	Alcohol 0.176 mg/dl; positive THC
Egress from vehicle:	Exited with assistance
Transport from scene:	Private conveyance to fire station and ambulance to hospital
Type of medical treatment	Hospitalized, removed from life support 5 days post-crash

Driver Injuries

Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Fracture of thyroid cartilage with vocal cord involvement	340210.4	Tandem IPC Initial: Interior – Interior loose object (specify): Cell phone Secondary: Front – Steering wheel rim	Possible Possible
2	Pharynx laceration	340604.2	Caused by other injury (#1)	Possible
3	Pneumomediastinum	442209.2	Caused by other injury (#1)	Possible
4	Contusion over the mid line of the neck	310402.1	Isolated Interior – Interior loose object: Cell phone	Possible
5	Abrasion over mid-line of the neck	310202.1	Isolated Interior – Interior loose object: Cell phone	Possible
6	Abrasion to the right side of neck **	310202.1	Isolated Left air bag – Steering wheel hub	Probable
7	Abrasion to top of right shoulder **	710202.1	Isolated Left air bag – Steering wheel hub	Probable
8	Left shoulder contusions **	710402.1	Isolated Interior - Shoulder portion of belt restraint	Probable

Source: Autopsy final report and hospital records

******** *These injuries were identified in post-mortem images of the driver.*

Driver Kinematics

The driver of the Saturn was seated with the power-adjustable seat positioned in a middle track position with the seatback adjusted with a normal recline angle. The gap between the bottom of the adjustable head restraint and top of the seat back was 5 cm (2.0 in). The driver was restrained by the manual 3-point lap and shoulder seat belt system. This was supported by EDR data indicating the system was buckled, frictional abrasions to the polymer surface of the latch plate and D- ring, and a D-ring transfer to the shoulder belt webbing. Pre-crash, the driver approached the concrete light post base on a right-arcing trajectory. EDR data indicated she released accelerator pedal pressure at 2.0 seconds prior to AE and applied the vehicle's brakes. The vehicle's speed decelerated from 31 km/h (19 mph) 2.0 seconds prior to AE to 29 km/h (18 mph) 1.0 second prior to AE. Her intent was to meet an acquaintance in the parking lot where the crash occurred. At the time of the crash, it was raining heavily. The driver was also holding a cell phone and was communicating with several people via text and calls, likely using the speakerphone, immediately prior to and at the time of the crash. The involved cell phone was 150.9 mm (5.94 in) long, 75.7 mm (2.98 in) wide, 8.3 mm (0.33 in) thickness, and weighed 194 grams (6.84 ounces).

Based on police records, cell phone records, the SCI crash reconstruction, and the sustained injuries and injury patterns, the driver was most likely out-of-position, forward with her head turned to the left. This position was due in part to the rainy conditions that obstructed her view out the side window. She was most likely looking through the cleared portion of the windshield attempting to locate the vehicle of her acquaintance that was parked forward and left of the Saturn's movement. In this driving position, the cell phone was most likely held forward of her torso/face in close proximity to the steering wheel rim/spoke as depicted in Figure 11. The surrogate in the figure is the same height as the Saturn driver and the seat is adjusted to a mid-track position.

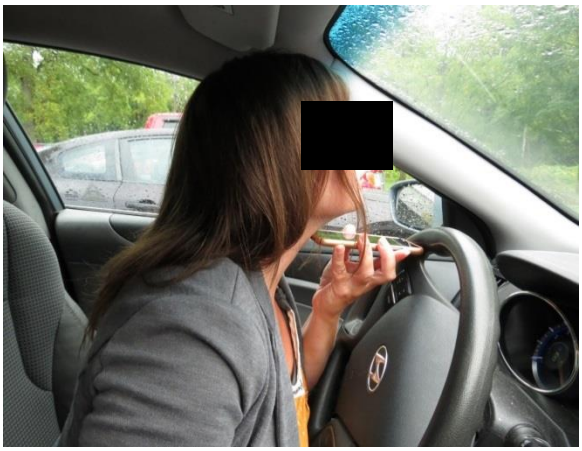


Figure 11. Image depicting the probable position of the Saturn driver and the cell phone at impact with the concrete base of the light pole

The front plane/left and center aspect of the Saturn struck the concrete base of the light pole. The resultant direction of force was 12 o'clock. The out-of-position driver initiated a forward trajectory in response to the impact force. Her anterior neck likely engaged the edge of the horizontally held cell phone and captured the phone against the steering wheel rim/spoke, causing a fracture of the thyroid cartilage with vocal cord involvement, a pharynx laceration, and an abrasion and contusion over the midline of the neck. The dimensions of the focal contusion and cartilage

fracture approximated the edge loading of the cell phone. The thyroid and pharynx injuries resulted in the pneumomediastinum.[1] This cell phone engagement occurred prior to air bag deployment as the driver responded to the frontal crash forces. At the time of deployment, the Saturn had experienced a longitudinal velocity change of 15.3 km/h (-9.5 mph). The air bag deployment was commanded at 54 milliseconds after AE.

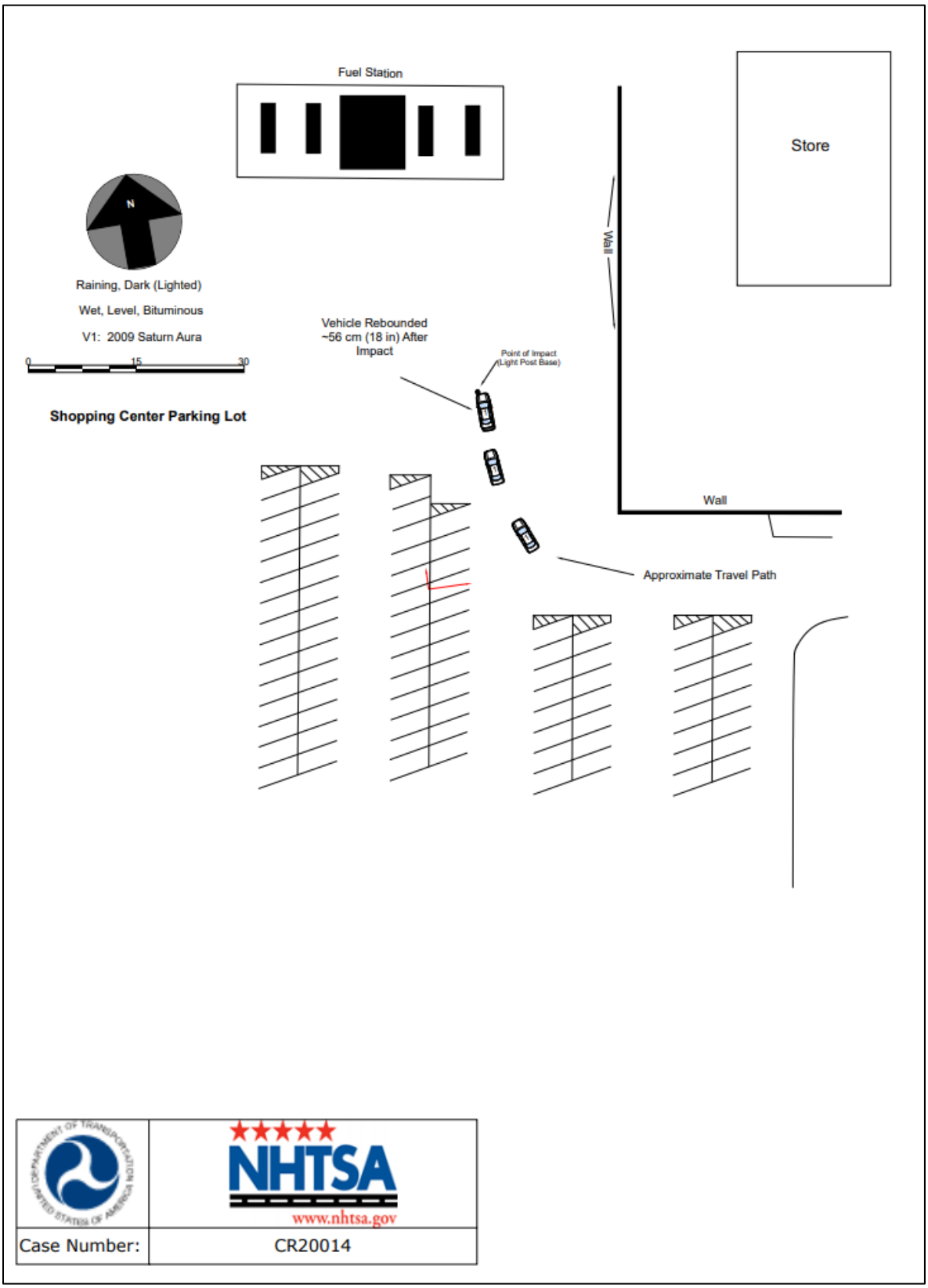
As the air bag deployed and the retractor pretensioner actuated, the driver's torso was in close proximity to the steering wheel. The tensioned seat belt webbing contused the left shoulder. The extent to which the pretensioner actuation may have altered her forward kinematic pattern is unknown. The expanding air bag contacted the right aspect of the driver's neck and upper right shoulder area, producing a wide abrasion pattern. As the air bag expanded, the driver continued to translate forward in response the increasing crash force (delta V). The combination of the driver's loading and the expanding air bag against the driver's torso compressed the energy-absorbing steering column less than 6 mm (0.25 in). This was evident by the separation of the shear capsules (bracket to block). Additionally, the left side of the steering wheel assembly deformed forward relative to the column and the mounting flange deformed.

The expanding air bag displaced the driver rearward into the seatback where she came to rest in the vehicle. She was assisted from the vehicle by the acquaintance, who saw the crash and arrived on-scene. The acquaintance transported the driver to a nearby fire station, where the medical records indicated that she suffered cardiac arrest. She was revived through CPR and was transported by ambulance to a trauma center. The driver was hospitalized for 5 days without recovery and began displaying indicators of hypoxic/anoxic insult to her brain. She was subsequently removed from life support and expired.

[1] "Pneumomediastinum is a condition in which air is present in the mediastinum. This condition can result from physical trauma or other situations that lead to air escaping from the lungs, airways or bowel into the chest cavity. Pneumomediastinum is a rare situation and occurs when air leaks into the mediastinum." *Journal of Thoracic Disease*, www.ncbi.nlm.nih.gov/pmc/articles/PMC4332083/

"Mediastinum, the anatomic region located between the lungs that contains all the principal tissues and organs of the chest except the lungs. It extends from the sternum, or breastbone, back to the vertebral column and is bounded laterally by the pericardium, the membrane enclosing the heart, and the mediastinal pleurae, membranes that are continuous with those lining the thoracic cage. The mediastinum is a division of the thoracic cavity; it contains the heart, thymus gland, portions of the esophagus and trachea, and other structures." 2021 Encyclopædia Britannica, Inc., www.britannica.com/science/mediastinum

Crash Diagram



Appendix A: 2009 Saturn Aura Event Data Recorder Report

The EDR report 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	1G8ZV57B99F******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CDR UPDATED TO 21.0.1.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 19.4
Imaged with Software Licensed to (Company Name)	Company Name information was removed when this file was saved without VIN sequence number
Reported with CDR version	Crash Data Retrieval Tool 21.0.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Deployment

Comments

No comments entered.

Data Limitations

Recorded Crash Events:

There are two types of recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). The minimum SDM Recorded Vehicle Velocity Change, that is needed to record a Non-Deployment Event, is five MPH. A Non-Deployment Event may contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle velocity change. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as Deployment Event #2, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds of a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM.
The second type of SDM recorded crash event is the Deployment Event. It also may contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. If a second Deployment Event occurs any time after the Deployment Event, the Deployment Event #2 will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Velocity Change reflects the change in velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. For Deployment Events, the SDM can record up to 220 milliseconds of data after Deployment criteria is met and up to 70 milliseconds before Deployment criteria is met. For Non-Deployment Events, the SDM can record up to the first 300 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.
-The CDR tool displays time from Algorithm Enable (AE) to time of Deployment command in a Deployment event and AE to time of maximum SDM recorded vehicle velocity change in a Non-Deployment event. Time from AE begins when the first air bag system enable threshold is met and ends when Deployment command criteria is met or at maximum SDM recorded vehicle velocity change. Air bag systems such as frontal, side, or rollover, may be a source of an enable. The time represented in a CDR report can be that of the enable of one air bag system to the Deployment time of another air bag system.
-Maximum Recorded Vehicle Velocity Change is the maximum square root value of the sum of the squares for the vehicle's combined "X" and "Y" axis change in velocity. If a CDR Printout user were to calculate resultant velocity change using X and Y axis time history data, the calculated value may be different than the Maximum SDM Recorded Velocity Change parameter value displayed in the CDR report. This is due to the rounding that occurs within the SDM while calculating the Maximum SDM Recorded Velocity Change value.
-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has

been interrupted and not fully written.
-SDM Recorded Vehicle Speed accuracy can be affected by various factors, including but not limited to the following:
-Significant changes in the tire's rolling radius
-Final drive axle ratio changes
-Wheel lockup and wheel slip
-Brake Switch Circuit Status indicates the open/closed state of the brake switch circuit.
-Pre-Crash data is recorded asynchronously. The 1.0 second Pre-crash data value (most recent recorded data point) is the data point last sampled before AE. That is to say, the last data point may have been captured just before AE but no more than 1.0 second before AE. All subsequent Pre-crash data values are referenced from this data point.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if:
-The SDM receives a message with an "invalid" flag from the module sending the pre-crash data
-No data is received from the module sending the pre-crash data
-No module is present to send the pre-crash data
-Vehicle speed, Transmission Gear Select, and Transmission Actual Gear will be marked as invalid for manual transmission vehicles
-Pre-crash data associated with this event will always be for the first event even if it is not recorded.
-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit, except: The Passenger Belt Switch Circuit Status for 2005 vehicles is available only on the Cadillac STS. The Passenger Belt Switch Circuit Status for 2006 Chevrolet Cobalt Sport Coupe (AP) model vehicles, with the option package that includes Recaro brand seats (RPO ALV), always reports a default value of "Buckled," because there is no passenger belt switch with the Recaro seat option. The Passenger Belt Switch Circuit Status for 2010 Chevrolet Cobalt and 2010 Pontiac G5 vehicles, with RPO Z49, will report a default value of "Buckled". The Passenger Belt Switch Circuit Status for 2010 and 2011 Chevrolet HHR, with the LS or LT trim package and RPO Z49, will report a default value of "Buckled".
-The Time Between Non-Deployment to Deployment Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time. If the value is negative, then the Deployment Event occurred first. If the value is positive, then the Non-Deployment Event occurred first. Time Between events is measured from end of one event to the beginning of a next event. An event may occur within 5 seconds of another event, known as an extended event. This occurs when three or more sequential events are separated by more than 5 seconds but each event in the sequence is no more than 5 seconds apart from a subsequent event. Pre-crash data is locked to the first event in an extended event.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-The ignition cycle counter relies upon the transitions through OFF->RUN->CRANK power-moding messages, on the GMLAN communication bus, to increment the counter. Applying and removing of battery power to the module will not increment the ignition counter.
-Steering Wheel Angle data is reported in 16 degree increments. 2005 through 2010 Chevrolet Cobalt, 2005 and 2006 Pontiac Pursuit, 2007 through 2010 Pontiac G5, and 2006 through 2011 Chevrolet HHR, do not record Steering Wheel Angle data and should not be relied upon.
-If more than one event is recorded, use the follow to determine which event the Multiple Event Data is associated with:
-If a Deployment event and not locked Non-Deployment event are recorded, the Multiple Event Data is associated with the Deployment event.
-If a Deployment event and a locked Non-Deployment event are recorded, then the Multiple Event Data is associated with both events.
-If a Deployment event and Deployment event #2 are recorded, then the Multiple Event Data is associated with both events.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Status Data (Pre-Crash) is transmitted to the SDM, by various vehicle control modules, via the vehicle's communication network.
-The Belt Switch Circuit is wired directly to the SDM.

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 all 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
Longitudinal Velocity Change	Forward
Lateral Velocity Change	Left to Right
Lateral Acceleration	Left to Right
Yaw Rate	Clockwise *
Steering Wheel Angle	Clockwise *

*For Cadillac STS model vehicles with StabiliTrak 3.0 systems (RPO JL7), the positive sign notation Indicates a counterclockwise rotation.

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 tool.

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Multiple Event Data

Associated Events Not Recorded	0
An Event(s) Preceded the Recorded Event(s)	No
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	No
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	No

System Status At AE

Vehicle Identification Number	**8ZV57B*9*******
Low Tire Pressure Warning Lamp (If Equipped)	OFF
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active
Brake System Warning Lamp (If Equipped)	OFF

System Status At 1 second

Transmission Range (If Equipped)	Third Gear
Transmission Selector Position (If Equipped)	Sixth Gear
Traction Control System Active (If Equipped)	No
Service Engine Soon (Non-Emission Related) Lamp	OFF
Service Vehicle Soon Lamp	OFF
Outside Air Temperature (degrees F) (If Equipped)	53
Left Front Door Status (If Equipped)	Closed
Right Front Door Status (If Equipped)	Closed
Left Rear Door Status (If Equipped)	Unused
Right Rear Door Status (If Equipped)	Unused
Rear Door(s) Status (If Equipped)	Closed

Pre-crash data

Parameter	-2 sec	-1 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No

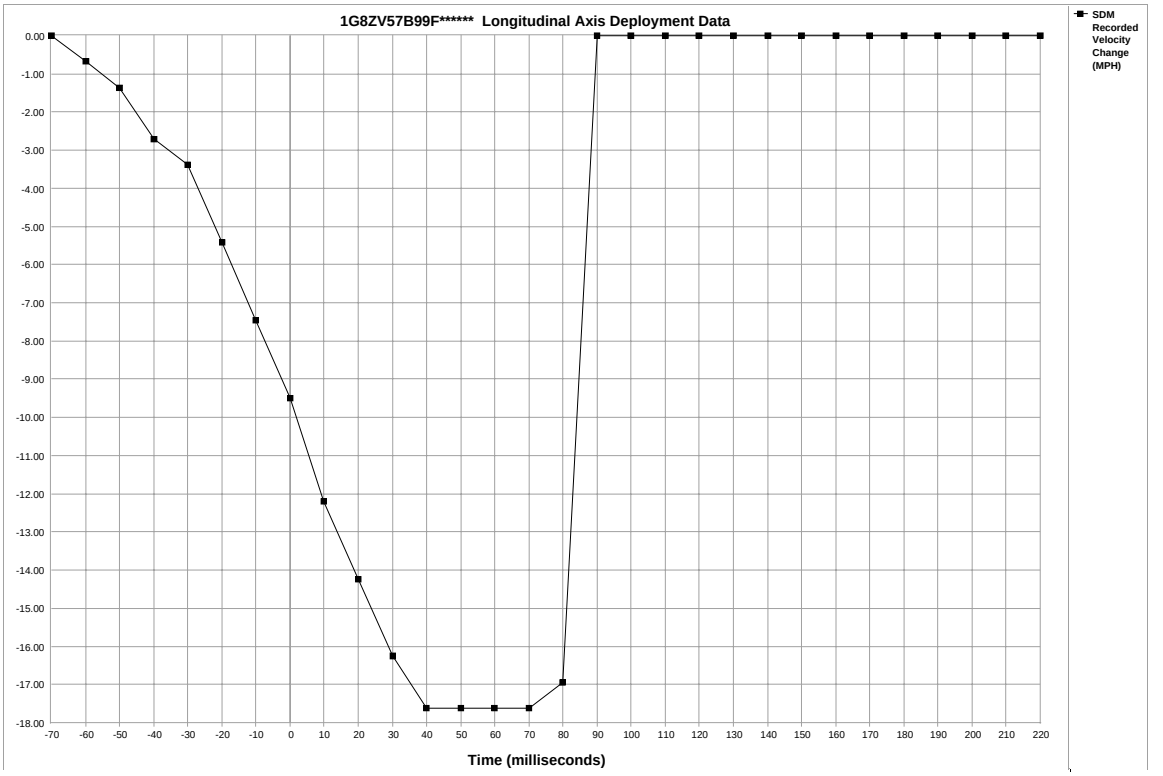
Pre-Crash Data

Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Vehicle Speed (MPH)	12	16	19	19	18
Engine Speed (RPM)	1984	2240	2176	1408	1280
Percent Throttle	44	45	34	26	25
Brake Switch Circuit State	OFF	OFF	OFF	ON	ON
Accelerator Pedal Position (percent)	29	29	11	0	0
Antilock Brake System Active (If Equipped)	No	No	No	No	No
Lateral Acceleration (feet/s²)(If Equipped)	-0.82	0.82	1.64	0.82	-0.82

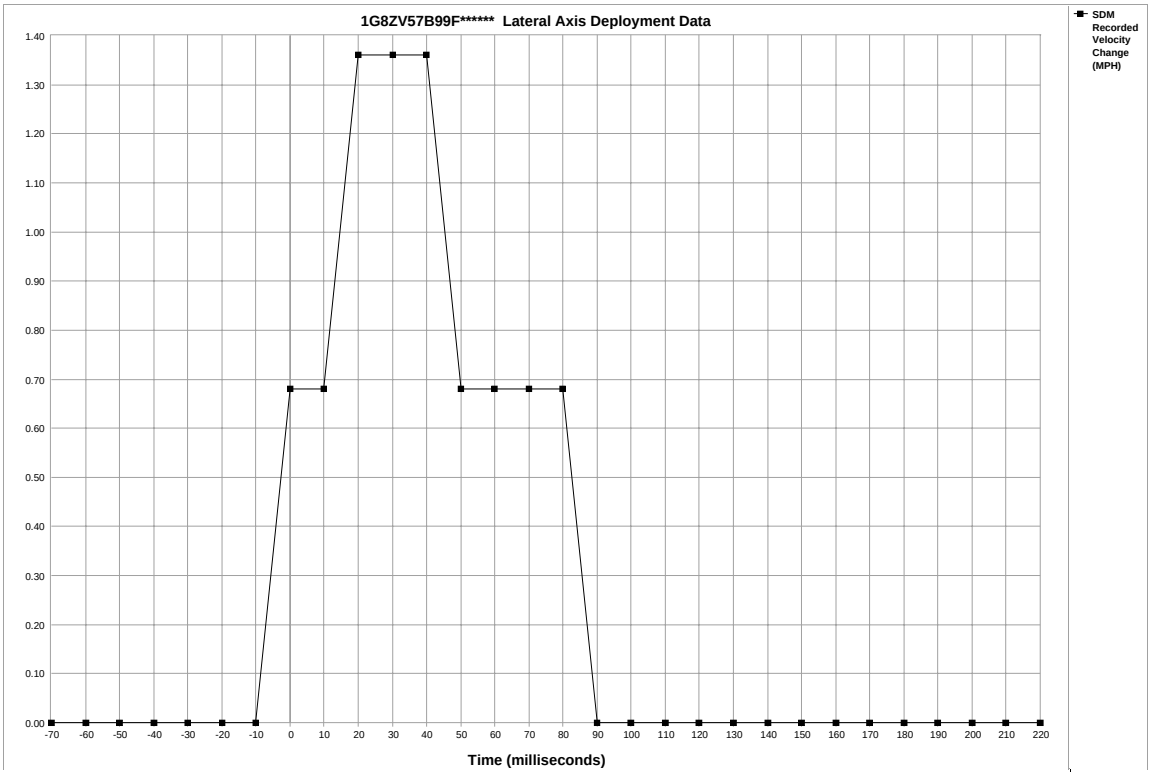
Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Yaw Rate (degrees per second) (If Equipped)	-1	4	3	2	0
Steering Wheel Angle (degrees) (If Equipped)	16	48	32	32	32
Vehicle Dynamics Control Active (If Equipped)	No	No	No	No	No

System Status At Deployment

Ignition Cycles At Investigation	21344
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time (seconds)	655200
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	3295
Ignition Cycles At Event	21343
Ignition Cycles Since DTCs Were Last Cleared	254
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Belt Switch Circuit Status (If Equipped)	UNBUCKLED
Diagnostic Trouble Code at Event Enable, fault number: 1	N/A
Diagnostic Trouble Code at Event Enable, fault number: 2	N/A
Diagnostic Trouble Code at Event Enable, fault number: 3	N/A
Diagnostic Trouble Code at Event Enable, fault number: 4	N/A
Diagnostic Trouble Code at Event Enable, fault number: 5	N/A
Diagnostic Trouble Code at Event Enable, fault number: 6	N/A
Automatic Passenger SIR Suppression System Validity Status at AE	Valid
Automatic Passenger SIR Suppression System Status at AE	Air Bag Suppressed
Automatic Passenger SIR Suppression System Validity Status at First Deployment Command	Valid
Automatic Passenger SIR Suppression System Status at First Deployment Command	Air Bag Suppressed
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	54
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	156
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Driver Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Passenger Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Time Between Events (sec)	N/A
Driver First Stage Deployment Loop Commanded	Yes
Driver Second Stage Deployment Loop Commanded	Yes
Driver Side Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop Commanded	Yes
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Passenger Pretensioner Deployment Loop Commanded	Yes
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Third Row Left Roof Rail/Head Curtain Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Third Row Right Roof Rail/Head Curtain Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded for Disposal	Yes
Passenger 2nd Stage Deployment Loop Commanded for Disposal	No
Crash Record Locked	Yes
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
Event Recording Complete	Yes



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Longitudinal Axis Recorded Velocity Change (MPH)	0.00	-0.68	-1.36	-2.71	-3.39	-5.42	-7.45	-9.49	-12.20	-14.23	-16.26	-17.62	-17.62	-17.62	-17.62
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Longitudinal Axis Recorded Velocity Change (MPH)	-16.94	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Time (milliseconds)	-70	-60	-50	-40	-30	-20	-10	0	10	20	30	40	50	60	70
SDM Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.68	0.68	1.36	1.36	1.36	0.68	0.68	0.68
Time (milliseconds)	80	90	100	110	120	130	140	150	160	170	180	190	200	210	220
SDM Lateral Axis Recorded Velocity Change (MPH)	0.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hexadecimal Data

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$0B  00 00 05 0F 00 00 00
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$0D  00 00 40 00 00 00 00
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$12  37 30 00 00 00 00 00
$13  00 00 00 00 00 00 00
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$15  80 00 00 00 00 00 00
$16  00 00 00 20 40 40 00
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$B1  FD FE 00
$B2  FF FF FF FF FF
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$B8  44 45 84 02 05
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$CB  00 F1 A0 31
$CC  00 F1 A0 31
$D1  00 00
$DB  00 00
$DC  00 00
```

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.

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**National Highway
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