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Special Crash Investigations: On-Site Heavy Truck Underride Crash Investigation; Vehicle: 2014 Peterbilt; Location: Alabama; Crash Date: August 2019

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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 published.

16. Abstract

This on-site investigation documents the underride crash to an unknown make/model semi-trailer with a 2013 Nissan Altima. The Nissan underrode the back plane of the semi-trailer hauled by a 2014 Peterbilt truck-tractor as both vehicles were traveling south on an interstate highway. According to the police crash report, the Peterbilt's 47-year-old driver was belted and uninjured. The impact to the rear of the trailer resulted in the rear impact guard separating from the trailer frame at the right vertical support beam. The rear impact guard rotated counterclockwise on the left vertical support beam as the Nissan underrode the tractor-trailer. The tractor-trailer was driven away from the crash site at the conclusion of the on-site police investigation and was not available for inspection. The occupant compartment of the Nissan sustained severe damage as it impacted the rear-impact guard and underrode the back plane of the semi-trailer. The Nissan was equipped with multiple inflatable supplemental restraints to include front seat belt pretensioners, certified advanced 208-compliant frontal air bags, front seat mounted side impact air bags, and inflatable curtain air bags mounted to the roof side rails. The driver's seat belt pretensioner actuated and the driver's frontal air bag deployed as a result of the crash. The belted 31-year-old male Nissan driver sustained police-reported A-level (incapacitating) injuries and was transported by ambulance for treatment and hospitalized for 10 days. The Nissan was towed from the crash site by a local towing company.

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Special Crash Investigations
On-Site Heavy Truck Underride Crash Investigation
Case Number: CR19032
Vehicle: 2014 Peterbilt
Location: Alabama
Crash Date: August 2019

Background

This on-site investigation documents the underride crash to an unknown make/model semi-trailer (Figure 1) of a 2013 Nissan Altima. The Nissan underrode the back plane of the semi-trailer hauled by a 2014 Peterbilt truck-tractor as both vehicles were traveling south on an interstate highway. According to the police crash report, the Peterbilt's 47-year-old driver was belted and uninjured. The impact to the rear of the trailer resulted in the rear impact guard separating from the trailer frame at the right vertical support beam. The rear impact guard rotated counterclockwise on the left vertical support beam as the Nissan underrode the tractor-trailer. The tractor-trailer was driven away from the crash site at the conclusion of the on-site police investigation and was not available for inspection. The occupant compartment of the Nissan sustained severe damage as it impacted the rear-impact guard and underrode the back plane of the semi-trailer (Figure 2). The Nissan was equipped with multiple inflatable supplemental restraints to include front seat belt pretensioners, certified advanced 208-compliant frontal air bags, front seat mounted side impact air bags, and inflatable curtain (IC) air bags mounted to the roof side rails. The driver's seat belt pretensioner actuated and the driver's frontal air bag deployed as a result of the crash. The belted 31-year-old male Nissan driver sustained police-reported A-level (incapacitating) injuries and was transported by ambulance for treatment and hospitalized for 10 days. The Nissan was towed from the crash site by a local towing company.

Figure 1. Left front oblique view of the Nissan under the trailer towed by the 2014 Peterbilt. Local law enforcement provided image.

Figure 2. Left front oblique view of the Nissan

The crash was identified by the National Highway Traffic Safety Administration's Crash Injury Research and Engineering Network (CIREN) program and forwarded to the Special Crash Investigation (SCI) group for further research in September 2019. A limited on-site level investigation was assigned to the SCI team at Crash Research & Analysis Inc. in October 2019. The truck and trailer could not be located for inspection. Numerous calls to the trucking company were not returned and cooperation to inspect the trailer could not be established. However, on-scene images taken by the police were obtained and reviewed as a supplement to the inspection data. The insurance provider for the Nissan was contacted and authorization to inspect the vehicle was given in November 2019. The Nissan inspection consisted of measurements of the exterior deformation and interior intrusion, document evidence of occupant contact, and examine the manual and supplemental restraint systems for use. The Nissan was equipped with an event data recorder (EDR) supported by the Bosch Crash Data Retrieval (CDR) tool and it was imaged during the inspection process. Further on-site activities included documentation of the crash site using photographs, and a mapping of the roadway by total station. The Nissan driver was interviewed.

Summary

Crash Site

This crash occurred during the dark pre-dawn morning in the right lane of the southbound four-lane highway. Environmental conditions were clear visibility, calm winds, a temperature of 25 °C (78 °F), and a dew point of 23 °C (74 °F) according to local weather reports. The bituminous north/south divided highway (Figure 3) consisted of two lanes in each direction separated by a grass median and cable barrier. The southbound lanes had a grade of -1.2% and the road surface was dry. The lanes were approximately 3.5 m (11.4 ft) wide and were divided by a broken white lane line. The right edge line was solid white, and the left median line was solid yellow. The east shoulder was approximately 3.3 m (10.8 ft) wide and the west shoulder was approximately 1.1 m (3.6 ft) wide. The posted speed limit was 113 km/h (70 mph).

Figure 3. Southbound view of the roadway for the Peterbilt's and Nissan's pre-crash travel

Pre-Crash

Crash reconstruction determined that the speed of the Peterbilt was approximately 40 km/h (25 mph). This data was calculated by combining the Nissan's pre-crash speed and the delta V reported in the EDR. The Nissan driver was traveling south in the right lane of the highway. The EDR recorded speed of the Nissan was 124 km/h (77 mph) at 5 seconds prior to algorithm enable (AE) with a max speed of 125 km/h (78) mph at 1-second prior to AE. The Peterbilt was southbound in the right lane ahead of the Nissan traveling at a slower speed.

The EDR indicated that the driver reacted to the impending collision by applying the brake and steering to the right 0.5-seconds prior to AE. At impact, the EDR-recorded speed of the Nissan was115 km/h (71 mph). As reported by local law enforcement, it is probable that the use of a handheld device was the cause of the delayed reaction of the driver during its pre-crash travel.

Crash

The front of the Nissan struck the back of the trailer. The impact was offset to the trailer's right (Figure 4) and underrode the trailer 252 cm (99.2 in) based on the length of damage to the Nissan. The driver of the tractor-trailer stated to the police that he felt a bump when the impact occurred. He then started to slow down and steered to the right shoulder. The tractor-trailer

continued an additional 222.5 m (730 ft) after the impact and came to final rest facing south on the west shoulder with the Nissan lodged under the trailer.

Figure 4. The Nissan at final rest. Local law enforcement provided image.

Post-Crash

The emergency responders included police, firefighters, and ambulance personnel. According to the police report, the driver of the Peterbilt was uninjured. The Nissan driver was extricated from the vehicle. The police report indicated that the Nissan driver had a cell phone on his chest, by his arm, prior to extricating him. He was transported by ambulance to a local hospital and hospitalized with police-reported A-level (incapacitating) injuries.

2014 Peterbilt (Tractor-Trailer)

Description

The Peterbilt and trailer were not inspected. Numerous calls to the trucking company were not returned and cooperation to inspect the trailer could not be established. The Peterbilt tractor was identified by VIN 1XP4D49X0EDxxxxxx. The class 8, 6x4-drive tractor powered by a Cummins 14.9-liter, L6, diesel engine. Information on the trailer pulled by the Peterbilt was not documented by the police investigation. It is unknown if the tractor-trailer was loaded or empty and the gross weight is unknown.

Exterior Damage

The trailer pulled by the 2014 Peterbilt sustained damage to the rear plane from the impact (Figure 5). The impact to the rear of the trailer resulted in the rear impact guard separating from the trailer frame at the right vertical support beam, allowing the Nissan to underride the trailer 252 cm (99.2 in) forward. According to on-scene images, the rear impact guard appeared to comply with FMVSS 224 standards. Conspicuity tape was visible on the rear of the tractor-trailer and the rear impact guard appeared to extend the width of the trailer.

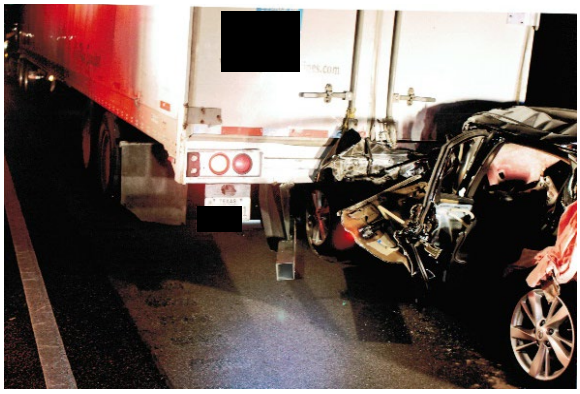


Figure 5. Damage to rear of trailer. Image supplied by police investigation.

2014 Peterbilt Occupant Data

Driver Demographics

Age/sex:	47 years/male
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat type:	Unknown
Seat track position:	Unknown
Manual restraint usage:	Lap and shoulder belt
Usage source:	Police crash report
Air bags:	Unknown
Alcohol/drug involvement:	No test given
Egress from vehicle:	Exited vehicle under own power
Transport from scene:	Not transported
Type of medical treatment:	No treatment

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Not injured	n/a	n/a	n/a

Source: police crash report.

Driver Kinematics

The driver of the Peterbilt was seated in an unknown posture and was restrained by the lap and shoulder seat belt. According to the police report, the driver was alerted to the incident when he heard a noise. After hearing the noise, the driver looked in his rearview mirror and noticed a shadow. At that time, the driver pulled off the roadway to see what had happened. The driver sustained no injuries and was not transported for treatment.

2013 Nissan Altima

Description

The 2013 Nissan Altima (Figure 6) was a front-wheel-drive, 4-door sedan with a Vehicle Identification Number of 1N4AL3AP6DCxxxxxx and equipped with a 2.5-liter, 4-cylinder, gasoline engine, linked to a continuously variable automatic transmission. The curb weight was 1,420 kg (3,130 lb). The service brakes were power-assisted, 4-wheel disc with ABS and electronic brake force distribution. The vehicle manufacturer recommended tire size was P215/60R16 with a recommended cold pressure of 220 kpa (32 psi). At the time of the crash, the Nissan was equipped with Michelin Primacy MXV4 tires, size P215/55R17 on the front axles and Goodyear ComforTred Touring tires, size P215/55R17 mounted on the rear axles.

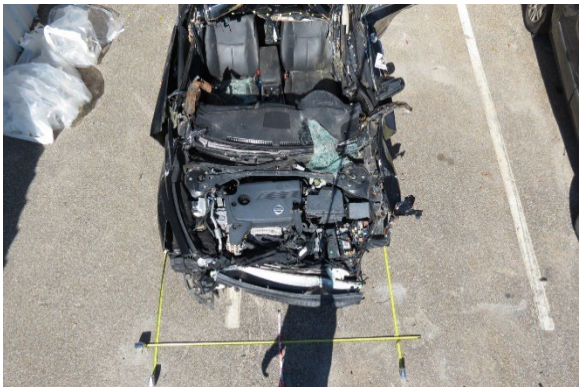


Figure 6. Overhead view of the Nissan depicting the frontal underride damage

The interior of the Nissan was configured for seating of five occupants with front bucket leather covered seats and a second-row leather-covered bench seat with folding backs. The driver seat was adjusted between the middle and rear track position and was reclined 30 degrees rearward of the vertical position. The driver's adjustable head restraint was found in the second row floorpan.

Vehicle History

A CARFAX report was obtained on the Nissan, which showed it was registered to two owners during its 6-year history. The current owner purchased the vehicle used on May 9, 2019, at the reported odometer reading of 92,543 km (57,504 mi). The CARFAX report listed mechanical service for the vehicle along with three crashes prior to this collision. An unknown level of service was performed on the air bag system in March 2019. CARFAX reported no safety recalls.

A query of the NHTSA recall database www.nhtsa.gov/recalls using the vehicle identification number for this specific Nissan Altima at the time of case assignment in October 2019 indicated that there were no unrepaired recalls for this vehicle. A second query of the NHTSA recall database was conducted in May 2022 with one unrepaired recall. NHTSA Recall Number 20V-315 was issued in May 2020 for the hood latch. This unrepaired recall was after the incident date and had no bearing on this incident.

Exterior Damage

The Nissan sustained damage to the front and top planes from the impact to the rear impact guard and backplane of the trailer (Figure 7). The direct damage at the elevation of the front bumper began at the left front bumper corner and extended to the right front bumper corner (Figure 8). Crush measurements were documented on the bumper beam using a 138 cm (54.3 in) field L. The residual crush values were: C1 = 10 cm (3.9 in), C2 = 22 cm (8.6 in), C3 = 27 cm (10.6 in), C4 = 31 cm (12.2 in), C5 = 34 cm (13.3 in), and C6 = 23 cm (9.0 in). The maximum residual crush of 34 cm (13.3 in) was located 20 cm (7.9 in) left of the right front bumper corner. The collision deformation classification for this damage profile was 12FDAA9. The "A" designation classifies impacts where the vehicle deformation resulted from an overhanging structure.

Figure 7. Front plane damage to the 2013 Nissan Altima

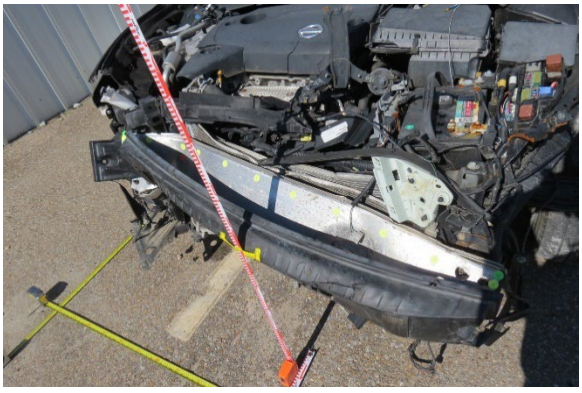


Figure 8. Frontal plane direct contact damage from impact to the back of the trailer

Analysis of this crash (delta V calculation) by WinSMASH was out of scope for the program due to the heavy truck impact and underride properties; however, the barrier algorithm of WinSMASH was used to calculate a barrier equivalent speed (BES) for comparative purposes. The BES calculation based on the bumper deformation was 35 km/h (21 mph).

The underride spanned the entire width of the Nissan's frontal plane and resulted in direct contact to the windshield header. The windshield header then crushed to the B-pillar area. The damage continued rearward as the Nissan underrode the tractor-trailer resulting in direct damage to the hood, windshield, and top plane beginning at the left A-pillar and extending across the windshield header to the right A-pillar (Figure 9). The right A-pillar deformed rearward approximately 65 cm (25.5 in) coming to rest against the right B-pillar.

Figure 9. Underride direct damage from impact to the back of the trailer

Both front doors were jammed shut and both rear doors remained closed during the crash and were operational. The laminated windshield was completely fractured due to impact forces. All glazing except the right rear window disintegrated due to impacting forces.

Event Data Recorder

The Nissan Altima was equipped with an air bag control module that performed the diagnostic, sensing, and deployment command functions for the vehicle's supplemental restraint systems. The EDR was imaged with the Bosch Crash Data Retrieval tool and software version 19.1.1 via direct connection to the module and reported with version 21.5. The EDR report is attached at the end of this report as Appendix A.

The data limitations reported that the EDR was capable of recording non-deployment events and deployment events and could store two event records. A non-deployment event could be overwritten. A deployment event has a higher priority than a non-deployment event and cannot be interrupted or overwritten by another event. Deployment events, by definition, result in air bags deploying due to deployment thresholds being reached and/or exceeded. The EDR is capable of recording pre-crash data as well.

The imaged data indicated that the Nissan's EDR had recognized and recorded one non-deployment event and one deployment event over the course of its history. Both events were completely recorded. The deployment event occurred on ignition cycle 6,281 while the non-deployment event occurred on ignition cycle 5,698. The non-deployment was not related to this crash. The ignition count at the time of the SCI investigation was 6,283.

The recorded deployment event (Event Record 2) was attributed to the impact with the rear plane of the trailer. During the event, the seat belt for the driver was recorded as buckled. The

maximum recorded longitudinal and lateral velocity changes were -77 km/h (-48 mph) and 4 km/h (2 mph), respectively. These occurred at 265 and 207.5 milliseconds (msec). The driver's seat belt pretensioner was commanded to actuate at 23 msec and the driver's frontal air bag was commanded to deploy, with the first stage deploying at 23 msec and the second stage deploying at 26 msec.

The EDR for Event Record 2 recorded 5 seconds of pre-crash vehicle performance parameters, which described the operation of the vehicle. The pre-crash data were measured asynchronously relative to AE. The recorded pre-crash data are listed in the following table in 0.5-second intervals:

Time seconds	Vehicle Speed km/h (mph)	Throttle Percentage	Engine RPM	Brake Switch Circuit Status	Steering Input
-5.0	124 (77)	20%	1,900	Off	0°
-4.5	124 (77)	22%	1,900	Off	0°
-4.0	124 (77)	22%	1,900	Off	0°
-3.5	125 (78)	22%	1,900	Off	0°
-3.0	125 (78)	22%	1,900	Off	-2.5°
-2.5	125 (78)	22%	1,900	Off	0°
-2.0	125 (78)	17%	1,900	Off	0°
-1.5	125 (78)	17%	1,900	Off	0°
-1.0	125 (78)	16%	1,900	Off	0°
-0.5	118 (73)	0%	1,900	On	-37.5°
-0.0	115 (71)	0%	1,800	On	-47.5°

*Although the manufacturer recommended tire size is P215/60R16, the tires on the vehicle were P215/55R17 which translates to a +2.7% higher speed than what is indicated in the EDR.

Examination of the data trends indicated a recorded steady speed from 5.0 to 1.0 second interval prior to AE. The data indicated that at 0.5 seconds prior to AE the brake switch was recorded as activated and the vehicle slowed to 118 km/h (73 mph). Also, the engine throttle was at 0 percent and there was a -37.5-degree (right) steering input. The data limitations stated that positive steering values indicated a left turn. According to the EDR, the vehicle speed at AE was 115 km/h (71 mph). However, based on the table footnote, the EDR-reported speed of 115 km/h (71 mph) calculates to an actual speed of 117 km/h (73 mph).

Interior Damage

The interior of the Nissan sustained significant intrusion damage from contact with the back plane of the tractor-trailer. The left and right A-pillar separated 30 cm (11.8 in) above the window sill. The intrusions attributed to this collision are listed in the following table:

	Row	Position	Component	Intrusion	Crush Direction
1	Front Row	Left	Windshield Header	34	Longitudinal
2	Front Row	Middle	Windshield Header	34	Longitudinal
3	Front Row	Right	Windshield Header	30	Longitudinal
4	Front Row	Left	A-pillar	75	Longitudinal
5	Front Row	Right	A-pillar	89	Longitudinal

The longitudinal intrusion of the windshield header and forward motion of the restrained driver resulted in the driver impacting the windshield header with his head (Figure 10).

Figure 10. Driver loading of windshield header

The underride of the Nissan resulted in the bottom surface of the tractor-trailer scraping the entire width of the top surface of the Nissan's instrument panel. The elevation of the top surface of the instrument panel measured 107 cm (42.1 in) from the ground.

Manual Safety Systems

The Nissan was configured with manual 3-point lap and shoulder seat belt systems for all five seating positions. All 3-point lap and shoulder seat belt systems consisted of continuous loop webbing with sliding latch plates. The front seat belts were equipped with retractor pretensioners. The driver's seat belts retracted onto an emergency locking retractor (ELR), while the other seat belts were equipped with a switchable ELR/ALR (automatic locking retractor). The pretensioners of both front restraints were tested and confirmed to be actuated during the SCI inspection.

The driver's anchorage adjustment was in the full-up position and the seat belt webbing was extended and lying in the driver's seat at the time of inspection. The right front seat belt was taut against the right B-pillar. There was fringing on the driver's seatbelt providing evidence of historical use. Additionally, the EDR data recorded that the driver belt system was "Buckled."

Supplemental Restraint Systems

The Nissan was equipped with dual-stage driver's and passenger's frontal air bags. The Nissan was also equipped with front seat-mounted side impact air bags and side impact IC air bags.

The driver's frontal air bag and module were separated from the steering wheel at the time of inspection and were found in the second row. The rear connectors on the air bag module were damaged upon inspection. The driver's frontal air bag and module likely were separated during the impact sequence due to contact with the back plane of the trailer. (Figure 11). Direct contact from the trailer was observed at the top sector of the steering wheel rim. The passenger's frontal air bag was suppressed and did not deploy.

Figure 11. View of the Nissan's deformed steering wheel

2013 Nissan Altima Occupant Data

Driver Demographics

Age/sex:	31 years/male
Height:	180 cm (71 in)
Weight:	86 kg (190 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Between middle and rear-most position
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle inspection, EDR
Air bags:	Frontal air bag; deployed Seat back mounted and IC; not deployed
Alcohol/drug involvement:	No test given
Egress from vehicle:	Removed from vehicle due to perceived serious injuries
Transport from scene:	Ambulance to a local hospital
Type of medical treatment:	Hospitalized for 10 days

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Comminuted displaced open fracture of distal shaft of left ulna	752274.3	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable
2	Comminuted displaced fracture of left distal ulna	752313.3	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable
3	Comminuted displaced fracture of left distal radius involving the joint	752361.2	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable
4	Comminuted displaced fracture of left distal shaft of radius	752271.2	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable
5	Comminuted displaced fracture of mid shaft of left humerus	751271.2	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable
6	Closed injury of head, not further specified	100099.9	Tandem IPC Initial: Roof – Front header Secondary: Exterior of Other Motor Vehicle – Rear surface	Certain Certain
7	Superficial lacerations to face	210602.1	Isolated IPC Roof – Front header	Certain
8	Superficial abrasions to face	210202.1	Isolated IPC Roof – Front header	Certain

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
9	Superficial laceration to left lateral chest wall	410602.1	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable
10	Laceration to left upper arm	710602.1	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable
11	Numerous right arm superficial lacerations	710602.1	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable
12	Numerous right arm abrasions	710202.1	Isolated IPC Exterior of Other Motor Vehicle – Rear surface	Probable

Source: emergency room records.

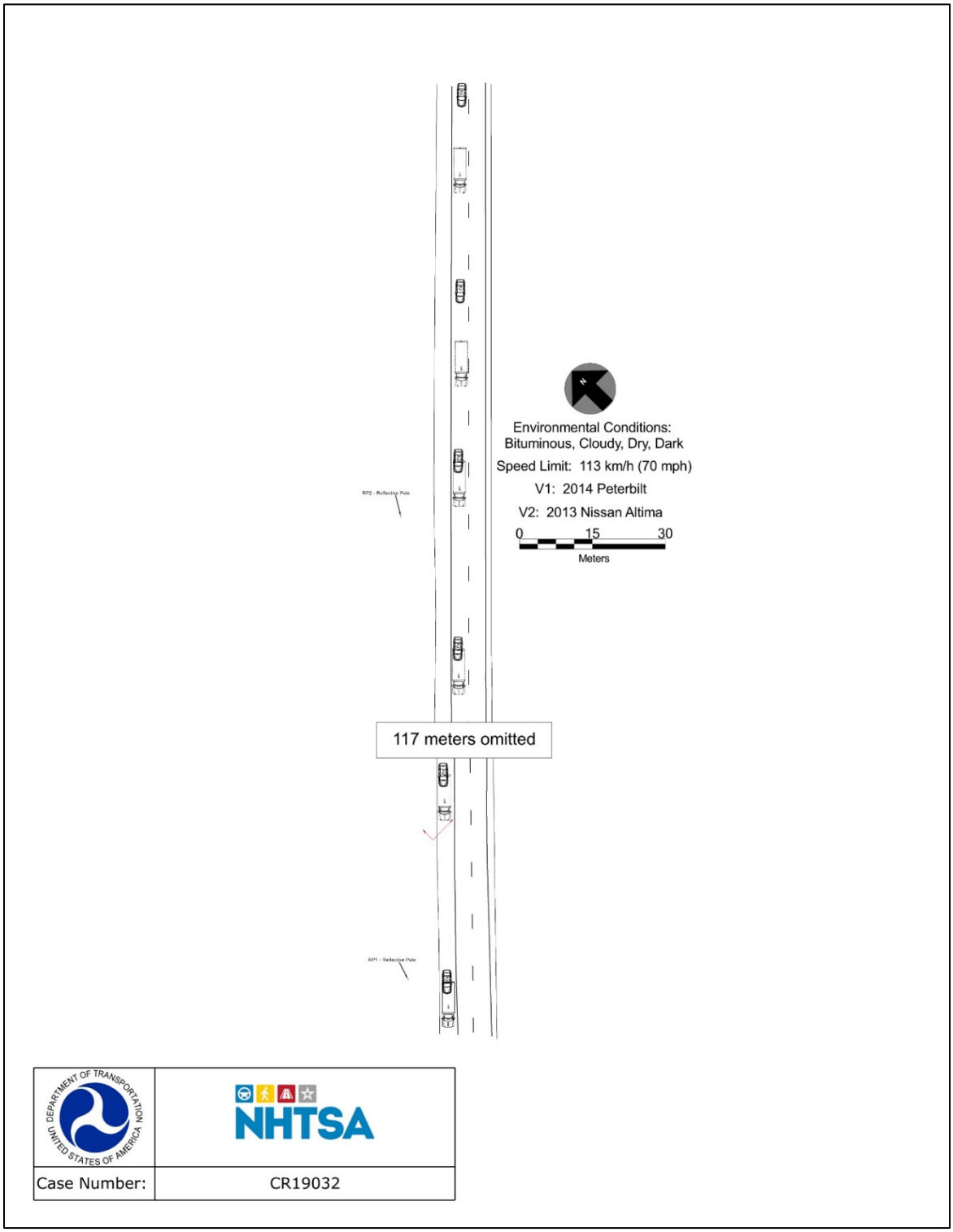
Driver Kinematics

The Nissan driver was seated in an unknown posture and was restrained by the lap and shoulder seat belt. The seat was between the middle and rear-most track position.

According to the police report, the driver was likely operating the vehicle while using a handheld device. He probably recognized the pending impact late in the pre-crash sequence, braked, and steered to the right as evidenced by the EDR. The underride impact with the trailer resulted in the forward motion of the driver, resulting in the driver's head impacting the left aspect of the intruding windshield header and likely impacting the trailer's back plane.

The driver sustained A-level (incapacitating) injuries and was transported by ambulance to a local hospital where he was hospitalized for 10 days and lost 42 days of work.

Crash Diagram



Appendix A: Event Data Recorder Report for 2013 Nissan Altima[1]

[1] The EDR report contained in this technical report was imaged using the version of the Bosch CDR software current 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	1N4AL3AP6DC******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CR19032_V1.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 19.1.1
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 21.5
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Event Record 1, Event Record 2

Comments

No comments entered.

Data Limitations

General Information:

Data limitations are intended to assist in reading event data that has been imaged from the vehicle's Air bag Control Unit (ACU). Event data should be considered in conjunction with other available physical evidence from the vehicle and scene.

Airbag Control Unit (ACU)

- The Air bag Control Unit (ACU) can store two types of events: Non-Deployment Events and Deployment.
  - A Non-Deployment Event is a crash or other physical occurrence which causes the ACU algorithm to be activated, but in which deployment thresholds are not reached.
  - A Deployment Event is a crash or other physical occurrence which causes ACU deployment thresholds to be reached or exceeded. Depending on the vehicle model, one or more of the following may be activated during a Deployment Event: front air bags, seat-mounted side airbags, roof-mounted or door-mounted curtain air bags, pretensioners, or pop-up roll bars.

- The ACU can record up to two events. If additional events occur subsequently, the older of the two events already recorded (i.e. the one which occurred first) is overwritten.
  - A Non-Deployment Event can be overwritten by another Non-Deployment event, or by a Deployment Event.
  - A Deployment Event has higher priority than a Non-Deployment Event, and cannot be interrupted or overwritten by another event.
  - The data pertaining to a Deployment Event is locked after being recorded. However, a second event can still be recorded subsequently in the portion of the event memory which is not locked.

- Event data includes both pre-crash data and crash data.
  - If the power supply to the ACU is lost during an event, all or part of the event data may not be recorded.
  - In addition to the recording of event data, the ACU has the ability to perform diagnostics and record Diagnostic Trouble Codes (DTCs).

Data Element Sign Convention:

The following table provides an explanation of the sign convention for data elements in the CDR report.

Data Element Name	Positive Sign Notation Indicates
Longitudinal Acceleration	Forward
Delta-V, Longitudinal	Forward
Maximum Delta-V, Longitudinal	Forward
Lateral Acceleration	Left to Right
Delta-V, Lateral	Left to Right
Maximum Delta-V, Lateral	Left to Right
Vehicle Roll Angle	Left to Right Rotation
Steering Input	Left Turn

- "Life Time Counter (sec)" indicates the elapsed time, in seconds, from the vehicle's first ignition activation until the start of the first recorded event. The counter is incremented whenever the vehicle's ignition is on. The counter is reset to 0 if the ACU is replaced.
- "Complete File Recorded" indicates whether a complete EDR data set has been stored after the event. "Yes" indicates that a complete data set has

been recorded. "No" indicates that only a portion of the data set has been recorded, for example due to the power to the ACU being lost during the event.
- "Multi-Event, Number of Events (1, 2)" indicates the number of events which are stored during a given ignition cycle. A Multi-Event occurs whenever the time between Event 2 trigger threshold and Event 1 trigger threshold is less than or equal to 5 seconds during the same ignition cycle, and "2" will be recorded in this case. Otherwise, "1" will be recorded.
- "Air Bag Warning Lamp (On, Off)" indicates whether the ACU was in trouble mode or in normal operation mode at the time of the event. "On" indicates that the air bag warning lamp was illuminated at the time of the event, and the ACU was in trouble mode. "Off" indicates that the air bag warning lamp was not illuminated at the time of the event, and the ACU was in normal operation mode.
- "Frontal Air Bag Suppression Switch Status" indicates whether front passenger air bag deployment was suppressed at the time of the event. "On" indicates that the front passenger air bag was suppressed at the time of the event (deployment inhibited). "Off" indicates that the front passenger air bag was not suppressed at the time of the event (deployment enabled). This data will not be available for all vehicles.
- "Delta-V, Longitudinal" indicates the cumulative change in velocity along the longitudinal direction.
- "Acceleration, Longitudinal" indicates the rate of change of velocity with time along the longitudinal direction.
- "Delta-V, Lateral" indicates the cumulative change in velocity along the lateral direction.
- "Acceleration, Lateral" indicates the rate of change of velocity with time along the lateral direction.
- "Engine Throttle, % full" indicates the position of the accelerator pedal as a percentage of the fully depressed position.
- "Service Brake (On, Off)" indicates whether the service brake is activated ("On") or not activated ("Off").
- "Steering Input (deg)" indicates the angular displacement of the steering wheel measured in degrees. -250 deg indicates a 250 degree turn to the right of the steering wheel, 0 deg indicates the straight-ahead steering wheel position, and 250 deg indicates a 250 degree turn to the left of the steering wheel.
- The notation "CLP" indicates that the measurement captured by a sensor exceeded the design range of the sensor.
- "Seat Track Position Switch, Foremost, Status, Driver (Yes/No)" indicates whether the driver's seat is positioned within a designated threshold value of the most forward adjustment position. "Yes" indicates that the driver's seat is positioned within a designated threshold value of the most forward adjustment position. For all other adjustment positions, "No" is displayed. This data will not be available if the seat track position switch is not installed in the vehicle.
- "Occupant Size Classification, Right Front Passenger, Child (Yes/No)" indicates whether or not the right front passenger is classified as a child (as defined in 49 CFR part 572, subpart N or smaller). This data will not be available for all vehicles.
- "e-pedal ON/OFF Status" indicates whether "e-pedal" is activated (ON), or not activated (OFF). This data will not be available for all vehicles.
- "ABS Warning lamp, on/off" indicates whether "Anti-lock Brake System" was in trouble mode or in normal operation mode at the time of the event. This data will not be available for all vehicles.
- "AEB/FCW switch status ON/OFF (from ADAS)" indicates whether the switch of "Automatic Emergency Braking or Forward Collision Warning controlled by ADAS unit" was ON, or OFF at the time of the event. This data will not be available for all vehicles.
- "AEB Warning lamp (from ADAS)" indicates whether "Automatic Emergency Braking controlled by ADAS unit" was in trouble mode or in normal operation mode at the time of the event. This data will not be available for all vehicles.
- "ABS regulation status" indicates whether "Anti-lock Brake System" was activated (ABS in regulation), or not activated (no ABS regulation). This data will not be available for all vehicles.
- "VDC switch status ON/OFF" indicates whether the switch of "Vehicle Dynamic Control" in ON, or OFF. This data will not be available for all vehicles.
- "VDC status/warning" indicates whether "Vehicle Dynamic Control" was in normal operation mode and not activated (No failure and no control), in trouble mode and not activated (Failure), or in normal mode and activated (In active control). This data will not be available for all vehicles.
- "Adaptive Cruise Control status" indicates whether "Intelligent Cruise Control status" was activated (ACC activated), waiting (ACC waiting), suspended (ACC suspended), or not activated (No display request). This data will not be available for all vehicles.
- "AEB operating capability" indicates whether "Automatic Emergency Braking" was in trouble mode (Impossible to execute request) or in normal operation mode (Braking fully operational). This data will not be available for all vehicles.
- "AEB Brake request (from ADAS)" indicates whether "Automatic Emergency Braking controlled by ADAS unit" was activated (Brake Torque AEB Maximum), or not activated (No Brake Request). This data will not be available for all vehicles.
- "VIN retrieval from other ECU " indicates VIN data retrieval from other ECU when CDR connect to vehicle by using OBD system if available.
- "VIN retrieval from ACU " indicates VIN data retrieval from ACU. It will not be available for all vehicles.
- "Motor RPM " indicates RPM of motor used for vehicle drive on electric or hybr id vehicles. In case of ICE vehicles, this indicates input shaft revolution that is input to Gearbox. This data will not be available for all vehicles.
- "Motor RPM2" indicates RPM of motor used for vehicle drive on electric vehicles. This data will not be available for all vehicles.

Hexadecimal Data:
All data that has been specified for retrieval is shown in the Hexadecimal Data section of this report. However, the Hexadecimal Data section may contain data that is not translated by the CDR tool.

Data Sources:
- Crash data is measured internally in the ACU.
- Pre-crash data is not measured internally in the ACU, but is transmitted from other control units through the Controller Area Network (CAN).
- Pre-crash data and crash data are asynchronous.

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DTCs at Time of Retrieval

DTC	Status	Description
B1421	Current	FRONTAL COLLISION DETECTION
U1000	Current	(CAN COMMUNICATION FAILER)
B0091	Current	B-PILLAR SATELLITE SENSOR LH [DISCONNECT]
B0096	Current	B-PILLAR SATELLITE SENSOR RH [DISCONNECT]
B0092	Current	C-PILLAR SATELLITE SENSOR LH [DISCONNECT]
B0097	Current	C-PILLAR SATELLITE SENSOR RH [DISCONNECT]
B00D5	Current	PASSENGER AIRBAG INDICATOR CIRCUIT [OPEN]
B0001	Current	DRIVER AIRBAG MODULE CIRCUIT [OPEN]
B0010	Current	ASSIST AIRBAG MODULE CIRCUIT [OPEN]
B1431	Current	FRONT PRE-TEN RH CIRCUIT [OPEN]
B1430	Current	FRONT PRE-TEN LH CIRCUIT [OPEN]
B1433	Current	FRONT PRE-TEN2 RH CIRCUIT [OPEN]
B1432	Current	FRONT PRE-TEN2 LH CIRCUIT [OPEN]
B0002	Current	DRIVER AIRBAG MODULE 2ND CIRCUIT [OPEN]
B0011	Current	ASSIST AIRBAG MODULE 2ND CIRCUIT [OPEN]
B0028	Current	SIDE AIRBAG MODULE RH CIRCUIT [OPEN]
B1421	Past	FRONTAL COLLISION DETECTION
B00A0	Trouble Diag. Record	OCCUPANT DETECTION SENSOR [POWER FAIL]
B142A	Trouble Diag. Record	IGN VOLTAGE [LOW]

System Status at Event (Event Record 1)

Life Time Counter (sec)	6660790
Complete File Recorded (Yes/No)	Yes (Complete)
Ignition Cycle, Crash	5698
Ignition Cycle, Download	6283
Multi-Event, Number of Events (1, 2)	1
Time from Event 1 to 2 (sec)	N/A
Safety Belt Status, Driver	On (Fastened)
Safety Belt Status, Right Front Passenger	Off (Unfastened)
Frontal Air Bag Warning Lamp (On, Off)	Off
Frontal Air Bag Suppression Switch Status	On (AS airbag inhibit)
Maximum Delta-V, Longitudinal (MPH [km/h])	-4 [-7]
Time, Maximum Delta-V, Longitudinal (msec)	300
Maximum Delta-V, Lateral (MPH [km/h])	-1 [-2]
Time, Maximum Delta-V, Lateral (msec)	245
Maximum Acceleration, Longitudinal (g)	-2.5
Time, Maximum Acceleration, Longitudinal (msec)	7.5
Maximum Acceleration, Lateral (g)	-.5
Time, Maximum Acceleration, Lateral (msec)	72.5

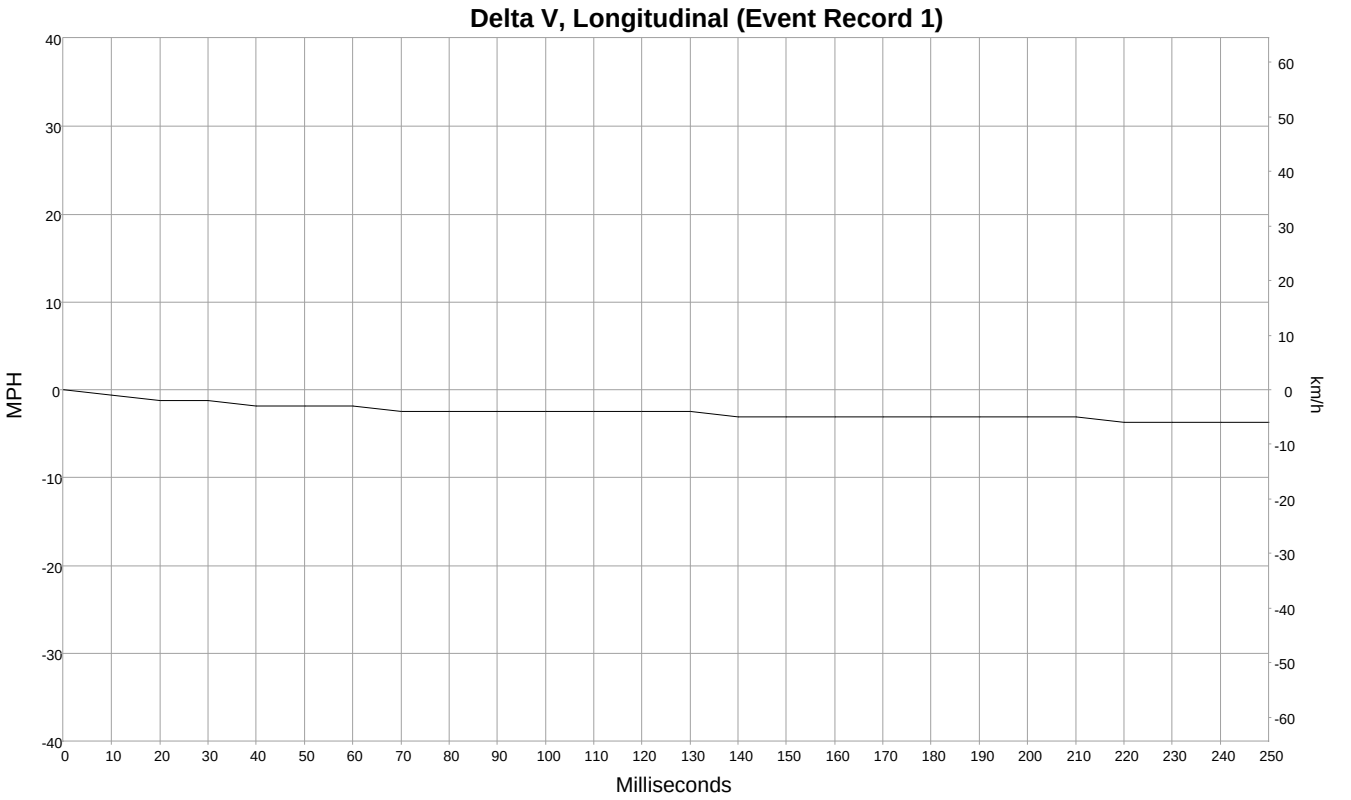
Deployment Command Data (Event Record 1)

Frontal Air Bag Deployment, Time to Deploy/First Stage, Driver (msec)	N/A
Frontal Air Bag Deployment, Time to Deploy/First Stage, Passenger (msec)	N/A
Frontal Air Bag Deployment, Time to 2nd Stage, Driver (msec)	N/A
Frontal Air Bag Deployment, Time to 2nd Stage, Right Front Passenger (msec)	N/A
Side Air Bag Deployment, Time to Deploy, Driver (msec)	N/A
Side Air Bag Deployment, Time to Deploy, Right Front Passenger (msec)	N/A
Side Curtain/Tube Air Bag Deployment, Time to Deploy, Driver Side (msec)	N/A
Side Curtain/Tube Air Bag Deployment, Time to Deploy, Right Side (msec)	N/A
Pretensioner Deployment, Time to Fire, Driver (msec)	N/A
Pretensioner Deployment, Time to Fire, Right Front Passenger (msec)	N/A

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Event Record 1)

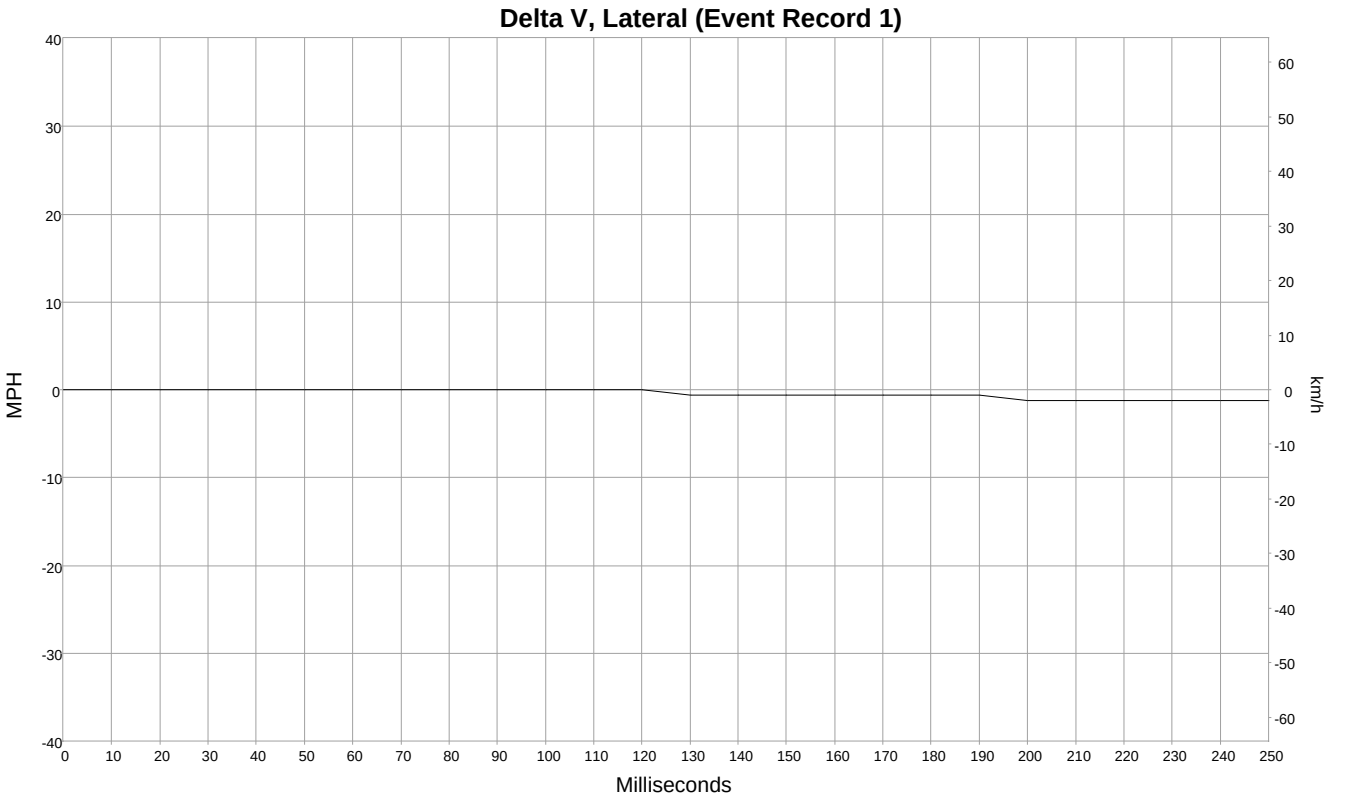
(the most recent sampled values are recorded prior to the event)

Time Stamp (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal, % full	Engine RPM	Motor RPM	Service Brake (On, Off)	Steering Input (deg)
-5.0	37 [60]	0	1200	1100	Off (Brake Not Activated)	0
-4.5	37 [59]	0	1100	1100	Off (Brake Not Activated)	0
-4.0	37 [59]	6	1100	1100	Off (Brake Not Activated)	0
-3.5	37 [59]	9	1200	1100	Off (Brake Not Activated)	0
-3.0	37 [59]	11	1400	1100	Off (Brake Not Activated)	0
-2.5	37 [59]	11	1700	1100	Off (Brake Not Activated)	0
-2.0	37 [59]	8	1700	1200	Off (Brake Not Activated)	0
-1.5	34 [54]	0	1300	1000	On (Brake Activated)	0
-1.0	24 [39]	0	900	800	On (Brake Activated)	30
-0.5	13 [21]	0	700	500	On (Brake Activated)	-2.5
0.0	11 [18]	0	600	400	On (Brake Activated)	-25



Longitudinal Delta V (Event Record 1)

Time (msec)	MPH [km/h]
0	0 [0]
10	-1 [-1]
20	-1 [-2]
30	-1 [-2]
40	-2 [-3]
50	-2 [-3]
60	-2 [-3]
70	-2 [-4]
80	-2 [-4]
90	-2 [-4]
100	-2 [-4]
110	-2 [-4]
120	-2 [-4]
130	-2 [-4]
140	-3 [-5]
150	-3 [-5]
160	-3 [-5]
170	-3 [-5]
180	-3 [-5]
190	-3 [-5]
200	-3 [-5]
210	-3 [-5]
220	-4 [-6]
230	-4 [-6]
240	-4 [-6]
250	-4 [-6]



Lateral Delta V (Event Record 1)

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

System Status at Event (Event Record 2)

Life Time Counter (sec)	7395941
Complete File Recorded (Yes/No)	Yes (Complete)
Ignition Cycle, Crash	6281
Ignition Cycle, Download	6283
Multi-Event, Number of Events (1, 2)	1
Time from Event 1 to 2 (sec)	N/A
Safety Belt Status, Driver	On (Fastened)
Safety Belt Status, Right Front Passenger	Off (Unfastened)
Frontal Air Bag Warning Lamp (On, Off)	Off
Frontal Air Bag Suppression Switch Status	On (AS airbag inhibit)
Maximum Delta-V, Longitudinal (MPH [km/h])	-48 [-77]
Time, Maximum Delta-V, Longitudinal (msec)	265
Maximum Delta-V, Lateral (MPH [km/h])	2 [4]
Time, Maximum Delta-V, Lateral (msec)	207.5
Maximum Acceleration, Longitudinal (g)	-34
Time, Maximum Acceleration, Longitudinal (msec)	190
Maximum Acceleration, Lateral (g)	-22
Time, Maximum Acceleration, Lateral (msec)	30

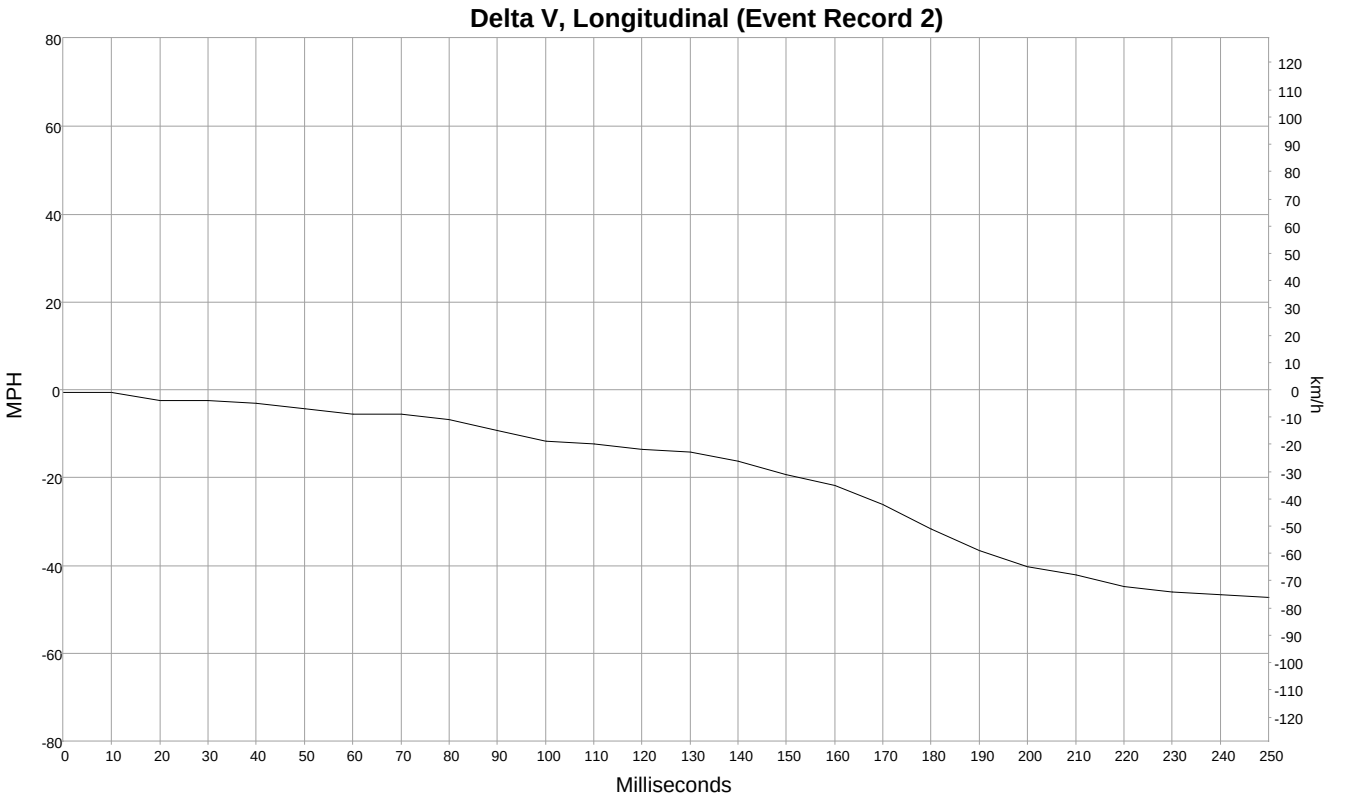
Deployment Command Data (Event Record 2)

Frontal Air Bag Deployment, Time to Deploy/First Stage, Driver (msec)	23
Frontal Air Bag Deployment, Time to Deploy/First Stage, Passenger (msec)	N/A
Frontal Air Bag Deployment, Time to 2nd Stage, Driver (msec)	26
Frontal Air Bag Deployment, Time to 2nd Stage, Right Front Passenger (msec)	N/A
Side Air Bag Deployment, Time to Deploy, Driver (msec)	N/A
Side Air Bag Deployment, Time to Deploy, Right Front Passenger (msec)	N/A
Side Curtain/Tube Air Bag Deployment, Time to Deploy, Driver Side (msec)	N/A
Side Curtain/Tube Air Bag Deployment, Time to Deploy, Right Side (msec)	N/A
Pretensioner Deployment, Time to Fire, Driver (msec)	23
Pretensioner Deployment, Time to Fire, Right Front Passenger (msec)	23

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Event Record 2)

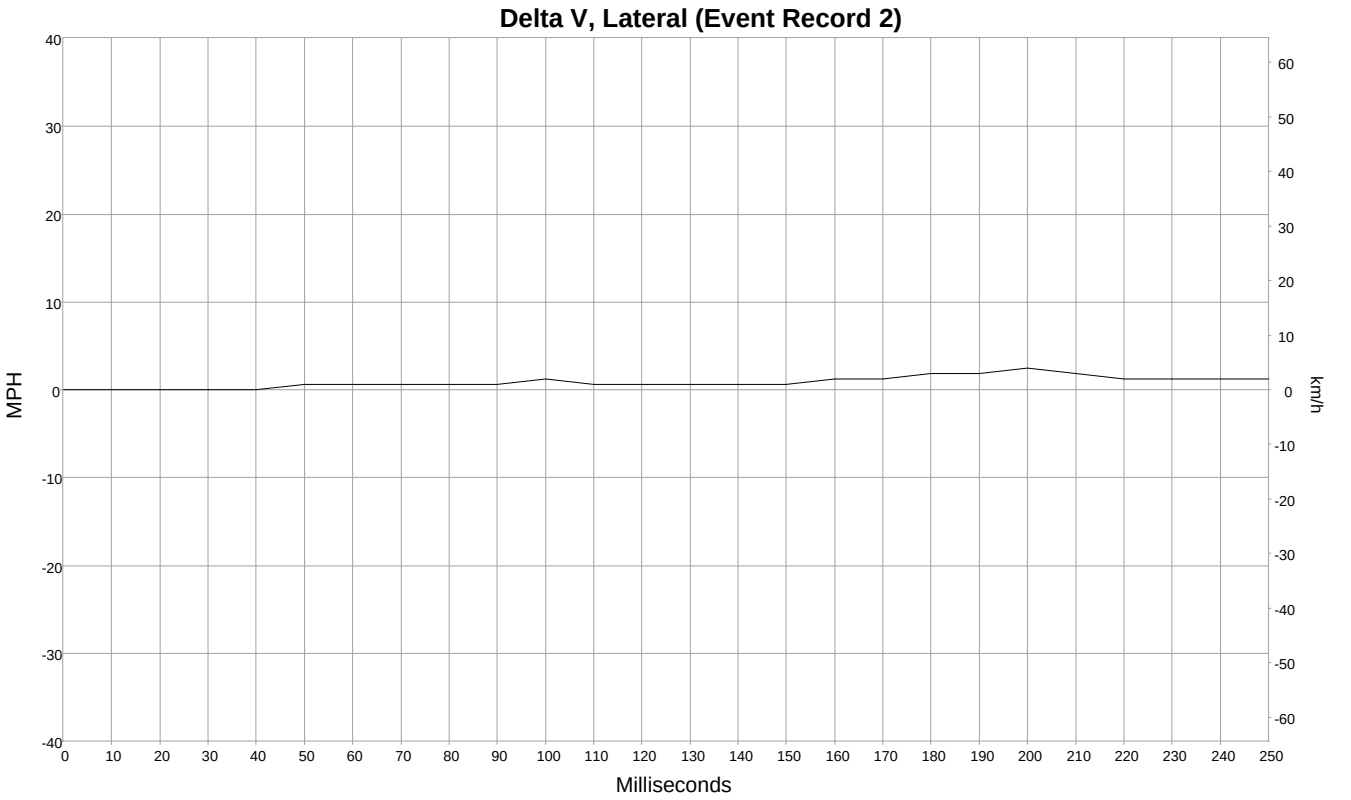
(the most recent sampled values are recorded prior to the event)

Time Stamp (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal, % full	Engine RPM	Motor RPM	Service Brake (On, Off)	Steering Input (deg)
-5.0	77 [124]	20	1900	1900	Off (Brake Not Activated)	0
-4.5	77 [124]	22	1900	1900	Off (Brake Not Activated)	0
-4.0	77 [124]	22	1900	1900	Off (Brake Not Activated)	0
-3.5	78 [125]	22	1900	1900	Off (Brake Not Activated)	0
-3.0	78 [125]	22	1900	1900	Off (Brake Not Activated)	2.5
-2.5	78 [125]	22	1900	1900	Off (Brake Not Activated)	0
-2.0	78 [125]	17	1900	1900	Off (Brake Not Activated)	0
-1.5	78 [125]	17	1900	1900	Off (Brake Not Activated)	0
-1.0	78 [125]	16	1900	1900	Off (Brake Not Activated)	0
-0.5	73 [118]	0	1900	1700	On (Brake Activated)	-37.5
0.0	71 [115]	0	1800	1600	On (Brake Activated)	-47.5



Longitudinal Delta V (Event Record 2)

Time (msec)	MPH [km/h]
0	-1 [-1]
10	-1 [-1]
20	-2 [-4]
30	-2 [-4]
40	-3 [-5]
50	-4 [-7]
60	-6 [-9]
70	-6 [-9]
80	-7 [-11]
90	-9 [-15]
100	-12 [-19]
110	-12 [-20]
120	-14 [-22]
130	-14 [-23]
140	-16 [-26]
150	-19 [-31]
160	-22 [-35]
170	-26 [-42]
180	-32 [-51]
190	-37 [-59]
200	-40 [-65]
210	-42 [-68]
220	-45 [-72]
230	-46 [-74]
240	-47 [-75]
250	-47 [-76]



Lateral Delta V (Event Record 2)

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

Hexadecimal Data

61 01 FF C0 00 94 21 00 D0 00 01 80 91 88 80 96 88 80 92 88 80 97 88 80 D5 13 80 01 13 80 10 13
94 31 13 94 30 13 94 33 13 94 32 13 80 02 13 80 11 13 80 28 13 14 FF FF FF FF 00 05 00 EF

61 02 80 A0 00 FF FF 03 0E 01 65 8E 00 94 2A 16 01 94 02 14 01 59 1A 00 00 00 00 00 00 00 00 00
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61 03 94 21 00 00 00 01 3F 01 8A 47 01 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
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61 04 00 00 03 81 00 00 00 FF FF CC 0A 00 00 00 00

61 06 99 9A 01 14 14 14 14 14 14 14 14 14 14 14 14 17 1A 17 1A 17 1A FF FF FF FF FF 66 0F 0F 0F
FF FF FF FF FF FF 0F 0F 0F FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF 7F 7F 7F 7F 00 00
00 00 00 00 00 00 00 00 FF 1F FF FF FA 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00 00 00 00 00 00 00 00 00 00

61 19 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00
00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01 00 00 00 01

61 1A 00 01 02 02 03 03 03 04 04 04 04 04 04 04 05 05 05 05 05 05 05 05 06 06 06 06 07 78 00 3C
00 3B 00 3B 00 3B 00 3B 00 3B 00 3B 00 36 00 27 00 15 00 12 00 00 00 00 00 06 00 09 00 0B 00 0B
00 08 00 00 00 00 00 00 00 00 01 01 01 01 01 01 01 00 00 00 00 16 42 18 8B 00 01 FF FF 01 FF 00
01 00 FF FF FF FF FF FF FF FF 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
80 80 80 80

61 1B 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 00 00 00 00
00 00 00 00 00 00 00 00 00 FF FF FF FF FF FF FF FE FE FE FE FE FE FE 62 00 0C 00 0B 00 0B 00 0C
00 0E 00 11 00 11 00 0D 00 09 00 07 00 06

61 1C 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 00
00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 0C FF FF FF F6 05 03 FF 1D 00 0B 00 0B 00 0B 00
0B 00 0B 00 0B 00 0C 00 0A 00 08 00 05 00 04 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
FF FF FF FF FF 00 65 A2 B6

61 1D 01 01 04 04 05 07 09 09 0B 0F 13 14 16 17 1A 1F 23 2A 33 3B 41 44 48 4A 4B 4C 4D 6A 00 7C
00 7C 00 7C 00 7D 00 7D 00 7D 00 7D 00 7D 00 7D 00 76 00 73 00 14 00 16 00 16 00 16 00 16 00 16
00 11 00 11 00 10 00 00 00 00 01 01 01 01 01 01 01 01 00 00 18 89 18 8B 00 01 17 FF 01 FF 00
01 00 1A FF FF FF FF FF 17 17 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80
80 80 80 80

61 1E 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 80 00 00 00 00
00 01 01 01 01 01 02 01 01 01 01 01 02 02 03 03 04 03 02 02 02 02 04 53 00 13 00 13 00 13 00 13
00 13 00 13 00 13 00 13 00 13 00 13 00 12

61 1F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F 00
00 00 00 00 00 00 00 00 01 00 00 00 00 00 00 00 00 FF F1 FF ED 44 4C D4 0C 00 13 00 13 00 13 00
13 00 13 00 13 00 13 00 13 00 13 00 11 00 10 FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF FF
FF FF FF FF FF 00 70 DA 65

61 83 33 54 41 30 43 07 31 44 32 07 01 01 01 02 00 21 00 07 00 03 32 20 20 83

59 02 09 94 21 00 09 D0 00 01 09 80 91 88 09 80 96 88 09 80 92 88 09 80 97 88 09 80 D5 13 09 80
01 13 09 80 10 13 09 94 31 13 09 94 30 13 09 94 33 13 09 94 32 13 09 80 02 13 09 80 11 13 09 80
28 13 09

59 02 09 94 21 00 09

59 0F 08 80 A0 00 08 94 2A 16 08

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U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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