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Special Crash Investigations On-Site Rollover Investigation Vehicle: 2016 GMC Yukon Denali Location: Florida Crash Date: October 2016

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants. Because each crash is a unique sequence of events, 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.

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16. Abstract This report documents the on-site investigation of the rollover crash of a 2016 GMC Yukon and the deployment of the vehicle's air bag systems. The crash occurred while the GMC was traveling on a multi-lane, limited-access roadway. When the GMC initiated a lane-change from the center lane into the left lane, its left rear corner struck the front right corner of a 2010 RAM. This imparted a counterclockwise rotation to the GMC and resulted in a loss of control by the GMC's driver. The GMC yawed counterclockwise into the median, struck a guardrail barrier system, and then tripped left side-leading into a multiple quarter-turn rollover sequence. The GMC was equipped with multiple inflatable supplemental restraints and a lane departure warning (LDW) system. There was no data in the GMC's EDR report concerning the LDW system, and the driver of the GMC refused interview. Therefore, the level of functionality of the LDW system and its role during the crash (if any) could not be determined. During the crash, the driver's frontal, both seat-mounted, and both dual-sensing (side impact and rollover) inflatable curtain (IC) air bags deployed. Injuries sustained by the 51-year-old male driver of the GMC were reported as possible (C-level), and an ambulance transported him to a local hospital for treatment.			
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CASE NO.: CR16032
ON-SITE ROLLOVER CRASH INVESTIGATION
VEHICLE: 2016 GMC YUKON
LOCATION: FLORIDA
CRASH DATE: OCTOBER 2016

BACKGROUND

This report documents the on-site investigation of the rollover crash of a 2016 GMC Yukon (**Figure 1**) and the deployment of the vehicle's air bag systems. The crash occurred while the GMC was traveling on a multi-lane, limited-access roadway. When the GMC initiated a lane-change from the center lane into the left lane, its left rear corner struck the front right corner of a 2010 RAM. This imparted a counterclockwise rotation to the GMC and resulted in a loss of control by the GMC's driver. The GMC yawed counterclockwise into the median, struck a guardrail barrier system, and then tripped left side-leading into a multiple quarter-turn rollover sequence. The GMC was equipped with multiple inflatable supplemental restraints and a lane departure warning (LDW) system. There was no data in the GMC's EDR report concerning the LDW system, and the driver of the GMC refused interview. Therefore, the level of functionality of the LDW system and its role during the crash (if any) could not be determined. During the crash, the driver's frontal, both seat-mounted, and both dual-sensing (side impact and rollover) inflatable curtain (IC) air bags deployed. Injuries sustained by the 51-year-old male driver of the GMC were reported as possible (C-level), and an ambulance transported him to a local hospital for treatment.

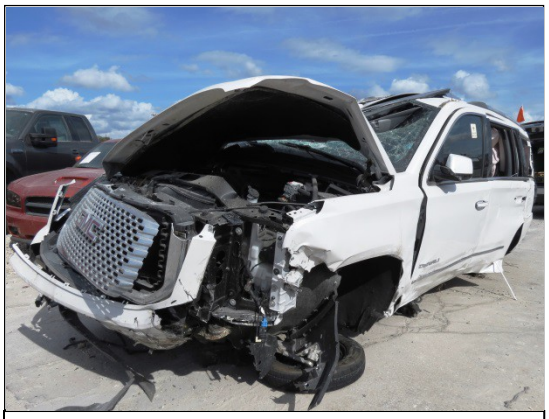


Figure 1: Left front oblique view of the 2016 GMC Yukon at the time of the SCI inspection.

The crash was identified by the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., in November 2016, through a routine review of vehicles listed online by a vehicle salvage facility. On the same day, a police Crash eport (PAR) was obtained to determine the nature of the crash and the injury status of the driver, and notification of the crash was provided to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration. The CID then assigned an on-site investigation of the crash to the SCI team. The SCI team initiated contact and established cooperation with the insurer and conducted the on-site investigation in November 2016. During the inspection process, data was imaged from the GMC's event data recorder (EDR) using the Bosch Crash Data Retrieval software and tool. The crash site was documented using a Nikon Nivo 5+M total station system and photographs. No

inspection of the RAM could be performed, because it was driven from the crash scene by its owner and could not be located. Medical record data concerning the GMC's driver was obtained from the treating facility.

CRASH SUMMARY

Crash Site

The crash occurred on a multi-lane, limited-access roadway one afternoon in October 2016. According to the National Weather Service, conditions in the locale at the time of the crash included overcast skies with a temperature of 26 °C (78 °F), 64 percent relative humidity, and a 29 km/h (18 mph) north-northeasterly breeze. Conditions documented by the PAR included daylight, cloudy, and dry. The physical environment of the roadway and crash site was documented by the SCI investigator using a Nikon Nivo 5.M+ total station mapping system.

Figure 2: Northbound trajectory view of the crash site at the time of the SCI inspection.

The crash occurred in the northbound lanes of a limited-access roadway that consisted of three travel lanes in both the north and southbound travel directions. It should be noted that according to the PAR, there was not an active work zone in place at the time of the crash. However, at the time of the SCI on-site inspection of the crash site (approximately 7 weeks after the crash) a work zone was established that closed the left northbound lane **(Figure 2)** and shifted traffic to the right. A double-faced W-beam guardrail system provided a physical division between the travel directions and was located in a 9.4 m (30.8 ft) wide grass median. The median barrier consisted of 10x15 cm (4x6 in) steel I-beam posts that were spaced on 1.8 m (6.0 ft) nominal centers with composite block outs on both sides of the posts. The barrier was offset in the median, located 5.4 m (17.7 ft) from the edge of the northbound lanes' west shoulder. The northbound travel lanes were all approximately 3.7 m (12.1 ft) in average width, delineated by broken white lane lines, a single solid-yellow median edge line, and a single solid-white right edge line. Tactile warning (rumble strips) were cut into the shoulders immediately outboard of the travel lane edge lines. The median (west) shoulder was 2.2 m (7.2 ft) in width, while the emergency (east) shoulder was 3.6 m (11.8 ft) wide. All travel lanes and shoulders were bituminous (asphalt) surfaced. The roadway was straight and level in the vicinity of the crash, with a normal (non-construction) posted speed limit of 113 km/h (70 mph).

Pre-Crash

The 51-year-old male driver of the GMC was traveling north in the center lane of the limited-access roadway. According to the data imaged from the GMC's EDR, the vehicle was traveling 127 km/h (79 mph) 5 seconds prior to algorithm enable (AE). He initiated a lane change maneuver to his left in an attempt to enter the left travel lane.

The 2010 RAM pickup truck was traveling in the left northbound lane at an unknown travel speed. Traveling in the same direction, the RAM was located slightly behind and to the left of the GMC as the two vehicles approached the area of the crash.

The driver of the GMC initiated the left lane change and encroached into the RAM's travel path. It remains unknown if either driver initiated steering or braking avoidance actions prior to the crash.

Crash

The first impact event occurred as the front right corner area of the RAM struck the left rear corner of the GMC. Directions of force were in the 1 o'clock sector for the RAM and the 7 o'clock sector for the GMC. The brief engagement of the vehicles induced a counterclockwise rotation to the GMC as its center of gravity continued in a northerly direction. This impact event resembled a PIT maneuver,[1] displacing the GMC from its tracking trajectory. Following the initial impact, the RAM initiated emergency braking and was brought to a controlled stop straddling the yellow edge line of the left travel lane. This was evidenced by two braking tire marks on the roadway surface that measured 47.1 m (154.5 ft) in length (**Figure 3**).

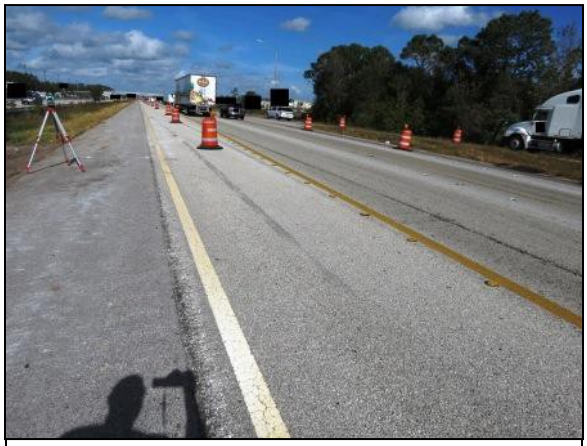


Figure 3: Northbound view of the braking tire marks from the RAM.

Figure 4: Northwest-facing view of the guardrail barrier system, replaced following the crash.

[1] Editor's note: A PIT (pursuit intervention technique) maneuver is a law enforcement pursuit tactic where a pursuing vehicle can force a fleeing vehicle to abruptly turn sideways, causing its driver to lose control and stop. Other names include pit block, pit stop, and blocking. The PIT maneuver was developed and named by the Fairfax County, Virginia, Police Department. Other interpretations of the acronym "PIT" include pursuit immobilization technique, precision immobilization technique, parallel immobilization technique, precision intervention tactic, among others. The technique is also known as tactical car intervention, tactical ramming, legal intervention, and fishtailing.

The GMC entered a counterclockwise yaw and traversed across the left travel lane, over the left shoulder, and into the grass median. As it maintained the counterclockwise rotation, it began to achieve a right side-leading attitude. The GMC's front plane then struck the face of the guardrail barrier system (Event #2), with an 11 o'clock direction of force. **Figure 4** depicts the replaced section of guardrail at the time of the SCI crash site inspection. According to data imaged from the GMC's EDR, the driver initiated braking action approximately 1.5 seconds prior to impact. The EDR-reported speed of the GMC at impact with the guardrail barrier system was 100 km/h (62 mph).

Crash forces deflected the GMC back toward the roadway as the vehicle maintained its counterclockwise rotation. The right side-leading attitude of the GMC in the area of the guardrail impact induced the dynamics of a right roll about the vehicle's longitudinal axis. However, the continued counterclockwise rotation about its vertical axis and its rebound off the guardrail system reversed the rolling dynamics. The GMC maintained its counterclockwise rotation and then achieved a left side-leading trajectory in the grass median as it surpassed 250 degrees of total counterclockwise rotation.

Its left side tires and wheels lightly gouged the soil/grass surface of the median, which tripped the vehicle into a left side-leading rollover (Event #3). The vehicle rolled a total of a minimum of eight quarter-turns along the median (**Figure 5**) before coming to rest on top of the median barrier guardrail system, in an upright attitude. The rollover initiation type was designated as trip-over, and the duration of the rollover sequence was uninterrupted. The total length of the GMC's roll was approximately 28 m (91.9 ft) from the initial trip point.

Figure 5: North-facing view of the GMC's rollover trajectory.

Post-Crash

Local law enforcement, fire department, and emergency medical services (EMS) personnel responded to the crash scene. The driver of the GMC unbuckled his manual seat belt restraint, opened the left front door, and exited the vehicle without assistance. He was evaluated at the scene by EMS personnel and transported to a local hospital, where he was treated for his injuries and released within hours of the crash. Following the on-scene police investigation of the crash, the GMC was recovered and towed to a local tow yard. It was subsequently transferred to a regional insurance vehicle salvage facility, where it was located for this SCI investigation. The RAM did not sustain disabling damage and was driven from the scene. It could not be located for inspection.

2016 GMC YUKON DENALI

Description

Figure 6: Front right oblique view of the 2016 GMC Yukon at the time of the SCI vehicle inspection.

The 2016 GMC Yukon (**Figure 6**) was a sport utility vehicle (SUV) manufactured in November 2015 and identified by the VIN 1GKS1CKJ9GRxxxxxx. A reading from the vehicle's electronic odometer could not be obtained during the SCI inspection due to electrical system inoperability. The rear-wheel drive GMC had a 295 cm (116 in) wheelbase. It was powered by a 6.2-liter, V-8 gasoline engine linked to an 8-speed automatic transmission, with a column-mounted shifter. A placard declared that the GMC's gross vehicle weight rating (GVWR) was 3,221 kg (7,100 lb). Front and rear gross axle weight ratings (GAWR) were 1,452 kg (3,200 lb) and 1,905 kg (4,200 lb), respectively. The GMC's curb weight was 2,487 kg (5,482 lb).

The GMC manufacturer's recommended tire size for all four positions was P285/45R22, at a recommended pressure of 240 kPa (35 psi). At the time of the SCI vehicle inspection, the GMC was equipped with Bridgestone Dueller H/L Alenza tires of the recommended size at the right front and right rear positions, mounted on 7-spoke OEM aluminum wheels. The left-side tires were completely separated and missing from the vehicle. The right-side tires had ample tread with matching Tire Identification Numbers of 8X84 FTO 4615.

The interior of the GMC was configured with three rows for the seating of up to seven occupants (2/2/3). The front row seats were bucket seats with 8-way power adjustments, and were equipped with adjustable head restraints. The driver's seat was adjusted to its full-rear track position at the time of the SCI inspection, with the seatback slightly reclined and the adjustable head restraint positioned 8 cm (3 in) upward. The front row right seat was also adjusted to its rearmost track position and with the seatback slightly reclined, but the head restraint was adjusted 2 cm (0.75 in) upward. The second row consisted of two captains' chairs with adjustable head restraints and fold-down center armrests. Both head restraints were in the full-down positions. The third row consisted of a forward-folding spilt-back bench seat with adjustable head restraints at the left and right positions. The seatbacks were folded forward to form a cargo floor. Manual restraint systems in the vehicle consisted of 3-point lap and shoulder seat belts for the six outboard positions, with a lap belt only for the third row position. Supplemental restraints consisted of Certified Advanced 208-Compliant (CAC) driver and passenger frontal air bags, driver and front right seat-mounted side impact air bags, a driver's seat-mounted center air bag, and dual-sensing (side impact

and rollover) inflatable curtain (IC) air bags that provided protection for all three rows. The GMC was also equipped with a steering column that featured electronic tilt and telescopic adjustments. Its adjustment settings could not be determined during the SCI inspection due to electrical system inoperability.

Exterior Damage

The GMC sustained exterior deformation to the left rear corner from impact with the RAM (Event 1), as well as damage to the front, roof, right, and left planes from the median barrier impact and rollover (Events 2 and 3). The Event 1 impact with the RAM involved the back left corner area of the rear bumper fascia (**Figure 7**). There was no residual structural deformation associated with this event. Despite the minimal damage, this event significantly altered the trajectory of the vehicle by imparting a counterclockwise rotation to the GMC due to its location on the vehicle with respect to the GMC's center of mass. The Collision Deformation Classification (CDC) assigned to the GMC for the Event 1 impact with the RAM was 07LBLN1, with a principal direction of force (PDOF) of 210 degrees.

Figure 7: Event 1 damage to the back left corner of the GMC's bumper fascia.

Figure 8: Front plane damage to the GMC.

Front plane engagement of the GMC with the median guardrail system resulted in front plane deformation and crush. The bumper fascia was fractured, with longitudinal crush to the underlying bumper beam. Direct contact began at the left front bumper corner and extended 70 cm (27.6 in) to the right, across the GMC's centerline. From a front plane perspective, the width of the direct and induced damage (Field-L) for the crush profile measured 118 cm (46.5 in) across the entire width of the bumper beam. A residual crush profile documented to the bumper beam produced the following resultant measurements: C1 = 25 cm (9.8 in), C2 = 10 cm (4.0 in), C3 = 9 cm (3.6 in), C4 = 11 cm (4.4 in), C5 = 5 cm (2.0 in), C6 = 2 cm (0.8 in). Maximum crush was located at the left front bumper corner (**Figure 8**). Based on the visible damage, the CDC assigned to the GMC for the Event 2 impact with the guardrail barrier system was 11FYEW1.

The barrier algorithm of the WinSMASH model was used to calculate the velocity change (delta-V) of the Event 2 impact. The total delta-V was 13 km/h (8 mph), with a longitudinal component of -11 km/h (7 mph) and a lateral component of 7 km/h (4 mph).

Following the frontal impact with the median guardrail system, the GMC rebounded to its right toward the roadway while maintaining its counterclockwise rotation. The vehicle achieved 270-degrees of total counterclockwise rotation (with respect to its original travel trajectory). It then tripped into the left side leading rollover event in the median, induced by the lateral drag force load on the left side tires/wheels. Both left side tires were separated completely from the GMC as a result of the tripping force and subsequent rollover (**Figure 9**). The GMC completed a minimum of eight quarter-turns during the rollover sequence, uninterrupted. Significant crush was sustained by the right roof side rail, right roof, and windshield header at the forward aspect of the greenhouse, associative to the rollover (**Figure 10**).

Figure 9: Event 3 rollover damage to the left plane of the GMC.

Figure 10: Roof crush to the GMC associative to the multiple quarter-turn rollover (Event 3).

The maximum vertical crush to the roof structure measured approximately 30 cm (11.8 in), and was located between the windshield header and sunroof opening above the front row right position. Maximum lateral crush measured 15 cm (5.9 in) to the right roof side rail, located adjacent to the front row right position. The CDC assigned to the GMC for the rollover (Event 3) was 00TDDO4. No WinSMASH calculations could be performed because the rollover crash type was beyond the scope of the model's capabilities.

Event Data Recorder

The 2016 GMC Yukon was equipped with an air bag sensing and diagnostic control module (SDM) mounted in the center tunnel. The SDM was equipped with an event data recorder (EDR) component, which was imaged during the SCI vehicle inspection using the Bosch Crash Data Retrieval (CDR) scan tool and software version 17.0. A connection was made to the SDM through the vehicle's diagnostic link connector (DLC) using supplemental power. The data was later read using software version 17.6.1, and is included at the end of this technical report as **Appendix A**.

The SDM monitored three-dimensional acceleration and commanded the actuation/deployment of pretensioners and inflatable supplemental restraints. The SDM also had EDR capabilities to record data for longitudinal, lateral, and/or rollover types. The EDR could store up to three crash event records for any combination of the three possible crash event types. However, the minimum vehicle velocity change required to store an event record to memory was 8 km/h (5 mph). Event records were termed "deployment" and "non-deployment" event types. By definition, a "deployment" event was any recognized event in which the SDM commanded deployment of any air bag system. A "non-deployment" event did not deploy air bags, but could include pretensioner actuation, active head restraint deployment (if equipped), and battery cut-off command (if equipped) events. Non-deployment events were subject to overwrite by subsequent events of greater severity or after approximately 250 ignition cycles, whereas deployment event types could not be overwritten.

The EDR had the capacity to record 300 milliseconds of data once the minimum threshold was achieved in longitudinal or lateral events, or 1000 milliseconds for rollover events (700 milliseconds pre-roll, 300 milliseconds post-roll). Associated to the recording of each respective event was a five second pre-crash buffer that recorded multiple pre-crash data points in 0.5 second intervals. Data recorded included accelerator pedal (% Full), service brake (On/Off) status, engine speed (rpm), engine throttle (% Full), vehicle speed (mph), cruise control state, and engine torque data. System status data, inclusive of reported Diagnostic Trouble Codes (DTCs), seat belt usage of front row occupants, and vehicle ignition cycle at the time of the event were also recorded. However, if power supply to the SDM was lost during or following a crash event, all or part of the data may not have been recorded to the EDR's memory.

Of note, there was no data related to the LDW system recorded or reported by the GMC's EDR. The recording and reporting of such data is not currently required by any Federal Motor Vehicle Safety Standard.

Data imaged from the GMC contained three recorded events, all of which were "deployment" event types. They occurred on ignition cycle 1,076, and the data was imaged on ignition cycle 1,077. For all three events, the driver's seat belt status was reported as "Buckled." Based on the cycle count, the recorded events were related to this investigated crash.

The SCI review of the imaged EDR data and reconstruction of the crash concluded that the three events indicated by the imaged EDR data corresponded to the second and third events of this crash. Event Record 1 of the imaged EDR data was a longitudinal event that correlated to the GMC's impact to the guardrail barrier system (SCI Event #2). Event Record 2 of the imaged EDR data was a rollover event that matched the dynamics of the left side-leading rollover (SCI Event #3). Lastly, Event Record 3 of the imaged EDR data was a lateral event to the left side, which was determined to be ground contact during the rollover event (SCI Event #3). The first crash event with the RAM was not recognized or recorded by the GMC's EDR, due to the minor severity of the associated impact forces which did not meet event recognition or recording threshold.

Event Record 1 was a front crash event with a reported a longitudinal delta-V of -18 km/h (-11 mph) and a lateral delta-V of 5 km/h (3 mph). These maximums occurred at 298 milliseconds and 180 milliseconds after algorithm enable (AE), respectively. The supplement restraint system deployment/actuation commands associated with Event Record 1 are listed in the following table:

Device	Time after AE (milliseconds)
Pretensioner, Driver	66
Pretensioner, Right front passenger	66
Frontal air bag, 1st Stage, Driver	66
Frontal air bag, 2nd Stage, Driver	189

Event Record 2 was a rollover event type that was recognized 0.04 seconds after Event Record 1. There was no longitudinal or lateral delta-V data associated with the event. However, roll angle data indicated that the GMC initiated a right side-leading roll (positive roll angle) that transitioned into a left side-leading roll (negative roll angle) as a result of the vehicle's continued counterclockwise rotation. Supplemental restraint system actuation/deployment commands associated with Event Record 2 are listed in the following table:

Device	Time after AE (milliseconds)
Side curtain air bag, left	253
Side curtain air bag, right	253
Seat-mounted center air bag	253

Both of the first recorded events, Event Record 1 and Event Record 2, shared an identical pre-crash buffer data set. The pre-crash data were summarized as follows:

Time	Accelerator Pedal (% Full)	Service Brake	Engine RPM	Engine Throttle (% Full)	Vehicle Speed
-5.0	0	ON	1,728	11	127 km/h (79 mph)
-4.5	26	OFF	1,728	23	126 km/h (78 mph)
-4.0	11	OFF	1,856	35	126 km/h (78 mph)
-3.5	30	OFF	1,792	35	127 km/h (79 mph)
-3.0	10	OFF	1,728	29	127 km/h (79 mph)
-2.5	21	OFF	1,728	23	126 km/h (78 mph)
-2.0	67	OFF	2,432	84	125 km/h (78 mph)
-1.5	12	ON	2,624	32	121 km/h (75 mph)
-1.0	0	ON	2,240	19	106 km/h (66 mph)
-0.5	0	ON	1,792	15	100 km/h (62 mph)

Event Record 3 was a lateral impact event that occurred 3.35 seconds after Event Record 1, during the multiple quarter-turn rollover. The reported longitudinal delta-V was 5 km/h (3 mph) and the lateral delta-V was 12 km/h (7 mph). These maximums occurred at 1968 milliseconds and 186 milliseconds after AE, respectively. Deployment of the driver's seat-mounted side impact air bag was commanded at 11 milliseconds. Pre-crash data associative to Event Record 3 was summarized as follows:

Time	Accelerator Pedal (% Full)	Service Brake	Engine RPM	Engine Throttle (% Full)	Vehicle Speed
-5.0	0	ON	2,240	19	106 km/h (66 mph)
-4.5	99	ON	1,664	22	93 km/h (58 mph)
-4.0	44	ON	2,432	93	89 km/h (55 mph)
-3.5	99	ON	3,712	99	94 km/h (58 mph)
-3.0	0	ON	4,480	40	102 km/h (63 mph)
-2.5	DATA NOT AVAILABLE				
-2.0					
-1.5					
-1.0					
-0.5					

Interior Damage

The interior of the GMC sustained significant damage that included intrusion of multiple components as a result of exterior deformation incurred during the Event 2 rollover. Although the combination of the driver's seat belt usage and the deployment of multiple air bags limited the driver's contact with interior components, minor contact evidence from the driver was documented in the vehicle's interior. The driver contacted the left IC air bag, resulting in a blood stain at the middle aspect of the IC air bag at the driver's position. Further contact evidence included a scuff to the lower instrument panel/knee bolster left of the steering column from the driver's left knee (**Figure 11**).

Figure 11: Driver left knee contact to the left lower instrument panel.

Figure 12: Forward-facing view of the GMC's interior depicting the significant vertical intrusion of the roof.

Intrusions into the occupant compartment of the GMC included vertical, lateral, and longitudinal displacement of the roof structure. Maximum intrusion was observed to the roof above the front row center position (**Figure 12**), which measured 32 cm (12.6 in) in magnitude. Additional intrusions documented during the SCI inspection included:

Location (Row/Position)	Component	Direction	Magnitude
1,1	Windshield header	Vertical	2 cm (0.8 in)
1,2	Windshield header	Vertical	22 cm (8.7 in)
1,3	Windshield header	Vertical	18 cm (7 in)
1,1	Roof	Vertical	3 cm (1 in)
1,2	Roof	Vertical	32 cm (12.6 in)
1,3	Roof	Vertical	28 cm (11 in)
1,3	Right roof side rail	Vertical	12 cm (4.7 in)
1,3	Right upper A-pillar	Vertical	12 cm (4.7 in)
1,3	Right upper A-pillar	Longitudinal	8 cm (3.1 in)
1,3	Right upper A-pillar	Lateral	15 cm (6 in)
1,3	Right roof side rail	Lateral	16 cm (6.3 in)
1,3	Right upper B-pillar	Lateral	10 cm (4 in)
2,3	Right roof side rail	Lateral	5 cm (2 in)
2,3	Right roof side rail	Vertical	2 cm (0.8 in)

The GMC was configured with an AS1 laminated windshield, AS2 laminated front door glazing, and AS3 tempered rear door, rear door quarter, rear (Row 3) quarter, backlight, and roof glazing. All operable glazings were closed at the time of the crash. The rollover event resulted in fracturing of the entire windshield surface with tearing of the laminate at the windshield header, fracturing of the right front door glazing, and disintegration of the left rear door, both left quarter, and the backlight glazing. The right rear door glazing remained intact, while the right third row glazing disintegrated. The roof window remained intact, but was partially displaced from its frame.

Manual Restraint Systems

The GMC was equipped with 3-point lap and shoulder seat belts for the six outboard seat positions, with a lap belt available for the third row center position. Only the driver's seat position was occupied at the time of the crash. The driver's seat belt system consisted of continuous loop webbing with a cinching latch plate that retracted onto an emergency locking retractor (ELR). The D-ring was height-adjustable; it was in the lowest position at the time of the crash.

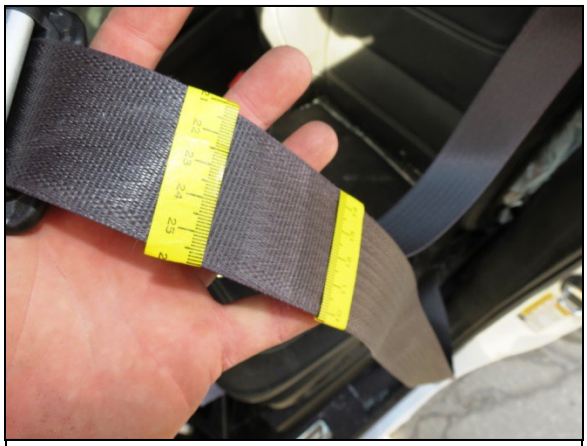


Figure 13: Frictional abrasion on the GMC's lap belt webbing from driver loading against the latch plate.

Frictional abrasions to the driver's manual seat belt system at the location of the D-ring and the latch plate evidenced driver loading. Latch plate loading evidence was located 76-81 cm (29.9-31.9 in) above the floor anchor (**Figure 13**). The D-ring abrasion was located 158 cm (62.2 in) above the referenced floor anchor. At the time of the SCI inspection, the webbing was locked in the worn position as a result of retractor pretensioner actuation. In total, a length of 158 cm (62.2 in) of excess webbing was extended from the retractor,

consistent with driver usage. It was apparent to the SCI investigator, based on the post-crash condition of the seat belt webbing and corroborated by the imaged EDR data, that the driver was restrained by the manual seat belt system at the time of the crash.

Supplemental Restraint Systems

The GMC was equipped with multiple inflatable supplemental restraints. The first of these systems was a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front row right positions. It consisted of a steering wheel hub-mounted driver air bag and a top instrument panel-mounted passenger's frontal air bag. The CAC system incorporated seat belt buckle switch sensors, a front right occupant presence (weight) sensor, and front seat belt retractor pretensioners. Additional occupant protection in the GMC consisted of front seat-mounted side impact air bags, a center air bag mounted in the right aspect of the driver's seat, and dual sensing roof side rail-mounted IC air bags. The driver's frontal, both driver's seat-mounted, and both IC air bags deployed during the crash (**Figure 14**).

Figure 14: View of the deployed driver's frontal, driver's seat-mounted side-impact, left IC, and center seat- mounted air bags within the GMC.

The driver's frontal air bag deployed from the steering wheel hub-mounted module without damage or occupant contact to the module cover flaps. In its deflated state, the air bag measured 70 cm (27.6 in) in overall diameter. It was tethered internally with an oval shape stich pattern on the face of the air bag that measured 16 x 8 cm (6.4 x 3.2 in). In its deflated state, the rearward excursion at the tether stitching was 34 cm (13.4 in). Two 5 cm (2.0 in) vent ports were located on the back side of the air bag at the 11 and 1 o'clock sectors. There was no damage or evidence of driver contact to the frontal air bag. A label identified the air bag as the following: "GM K2 XX DAB," "P621505800GG09," and "JTJ5X2S1BCM."

The front left seat-mounted side impact air bag deployed from the outboard aspect of the driver's seatback. The seat seam separated over a vertical length of 55 cm (21.7 in). In its deflated state, the air bag measured 62 cm (24.4 in) tall by 30 cm (11.8 in) wide. There was an 8 cm (3.2 in) vent port at the upper forward aspect of the air bag. No damage or contact evidence to the air bag was discernable. Identifying nomenclature on the air bag included: "AUTOLIV AIRBAG MODULE," "(0080) 0080.P1.12.0003," "SAB ASP-2 AQW," "625569101C L," "23425293," "4730701000000L," "813016342," and "UU152945293S01431."

The center seat-mounted air bag deployed through the right aspect of the driver's seatback with 55 cm (21.7 in) of separation of the stitching. Deflated, the air bag measured approximately 66 cm (26.0 in) in height and 48 cm (18.9 in) in width (longitudinal). This air bag provided protection against occupant-to-occupant interaction. There was no damage or contact evidence to the

deployed center air bag. A barcoded label contained the following nomenclature: “October 10 2015 012:36:50” and “2467187A532042//SL04A.”

The left and right IC air bags deployed from the roof side rails through the headliner. In their deflated states, both air bags measured approximately 277 cm (109.1 in) in overall length, extending from the A-pillar to the D-pillar. Although a small void existed at the location of the A-pillar, an externally sewn wide band tether was present between the IC air bag and the mid aspect of the upper A-pillar to fill this void. The vertical coverage of the IC air bags extended below the level of the beltline. At the mid aspect of the front row seat positions, the IC air bag measured 62 cm (24.4 in) in height. It was 54 cm (21.3 in) in height at the B-pillar, 58 cm (22.8 in) in height at the mid aspect of the second row, and 56 cm (22.0 in) in height between the C-pillar and D-pillar across the third row. A blood stain was present at the mid aspect of the left IC air bag adjacent to the driver’s position, covering 10 x 20 cm (4.0 x 8.0 in) area. There were no physical restrictions or damage to the IC air bags.

Rollover Discussion

The GMC initially departed the left roadway edge while engaged in a counterclockwise yaw. It then struck the median guardrail system with its front plane. During that time, the GMC achieved a right side- leading attitude and began the dynamics of a right roll about its longitudinal axis. However, the rebound of the vehicle off the guardrail and the continued counterclockwise rotation caused the GMC to achieve a left side leading attitude.

Its left side tires and wheels began to furrow into the grass/soil surface of the median as the vehicle achieved 270-degrees of total counterclockwise rotation, which instigated an abrupt tripping force that caused the vehicle to roll left side-leading. The GMC rolled a minimum of eight quarter turns, without interruption, as it continued in a northerly direction in the median. During the rollover, the vehicle contacted and mounted the guardrail system. This likely occurred during the second complete revolution of the vehicle, as evidenced by damage/deformation to the rear aspect of the GMC’s left plane. The vehicle ultimately came to final rest oriented in an upright fashion, facing east and straddling the median guardrail system. The total distance of the rollover from the trip location to final rest was approximately 28 m (92 ft).

The 2016 GMC Yukon Denali was tested by NHTSA in its Consumer Information Safety Rating System. Referring to www.nhtsa.gov, the four-wheel drive variant of the 2016 GMC Yukon Denali test vehicle, which was similar in features and curb weight to the focus vehicle, received a 3-star Rollover Rating in the NHTSA test. The calculated rollover risk was 22.2 percent. During an 80 km/h (50 mph) reverse steer test, the vehicle did not tip up.

Crash Avoidance

The 2016 GMC Yukon Denali was equipped with an enhanced driver alert and convenience package. This included a forward collision alert system (a type of forward collision warning without automatic braking), the LDW system with lane keep assist, and side blind zone alert (a type of blind spot detection). Due to the refusal of the driver for interview, no conclusions could

be made with regard to whether any of the GMC's crash avoidance (CA) systems were active or operational at the time of the crash. Furthermore, there was no data concerning these systems either monitored, recorded, or reported by the GMC's SDM or its EDR component. The recording of such data is not currently required by any FMVSS. The status of the CA systems and their involvement in the crash, if any, remains unknown.

NHTSA Recalls and Investigations

A query of www.nhtsa.gov using the GMC's VIN revealed that there was one active recall associated with this specific 2016 GMC Yukon Denali. It was opened on September 8, 2016, and was identified by the manufacturer No. 2016007 and by the NHTSA No. 16V651. The recall was issued after the date of the August 2016 crash; therefore, the vehicle had not received any service or maintenance relative to this recall. According to the recall notice, a potential defect in the SDM software could prevent the deployment of the frontal air bags and pretensioner actuation under certain circumstances. Although this recall was applicable to this GMC, it was noted by the SCI investigator that the driver's frontal air bag deployed and the driver's pretensioner actuated during the crash.

2016 GMC YUKON DENALI OCCUPANT DATA

Driver Demographics

Age/Sex:	51 years/male
Height:	Unknown
Weight:	129 kg (285 lb)
Eyewear:	Unknown
Seat Type:	Forward-facing bucket seat with adjustable head restraint
Seat Track Position:	Full-rear track position
Manual Restraint Usage:	3-point lap and shoulder seat belt
Usage Source:	Vehicle inspection/EDR/PAR
Air Bags:	CAC frontal, left front seat-mounted side-impact, left front seat-mounted center, and left IC air bags available; All deployed
Alcohol/Drug Involvement:	None, not tested
Egress From Vehicle:	Exited vehicle without assistance
Transport From Scene:	Ambulance to local hospital
Type of Medical Treatment:	Treated and released

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Acromioclavicular joint injury, left	770799.1	Safety belt system	Probable
2	Superficial laceration to left forehead	210602.1	Left roof	Probable

Source – Emergency Room records

Driver Kinematics

The 51-year-old male driver was positioned in the driver's seat with the track adjusted to its rearmost position, the seatback slightly reclined, and the adjustable head restraint 8 cm (3.2 in) upward. He utilized the available 3-point lap and shoulder seat belt system for manual restraint, determined from a combination of the post-crash condition of the seat belt system as observed during the SCI vehicle inspection and as indicated by the data imaged from the GMC's EDR.

At initial impact with the RAM, the driver was minimally displaced left and rearward. He possibly contacted the left front door panel with his arm and torso. However, no contact evidence was visible and no injury occurred to support such contact. The impact was of insufficient severity to induce occupant injury, but the associated forces initiated a counterclockwise rotation about the GMC's vertical axis. The driver responded to the counterclockwise rotation of the GMC by moving to his right as the vehicle yawed into the median and achieved a right side-leading orientation. No injury or contact evidence was produced.

At impact with the guardrail system, the driver initiated a forward trajectory. He loaded the manual seat belt system, and his knees contacted the left lower instrument panel. This contact did not produce occupant injury. The driver remained restrained by the seat belt as the vehicle rebounded off the guardrail system and rotated counterclockwise.

The driver then initiated a left lateral trajectory as the vehicle achieved its left side-leading orientation and tripped. Centrifugal forces associated with the rollover directed the driver laterally and vertically away from the longitudinal axis of the vehicle and its center of mass. This exacerbated the driver's loading of the manual seat belt system, which resulted in the left acromioclavicular joint injury. His left flank likely contacted the deployed left IC air bag, while his head likely contacted the left roof side rail and left roof. It is likely that the driver's contact with the roof, or a combination of the aforementioned contacts, produced the laceration to his left forehead. A small area of blood was observed on the left IC air bag, which likely correlated to post-crash contact by the driver during his egress from the vehicle.

The driver's use of the manual seat belt system and the actuation of the retractor pretensioner restricted his movement and prevented his complete displacement about the vehicle's interior during the multiple event crash sequence. Further, the combination of manual seat belt usage and deployment of multiple supplemental restraint systems (air bags) prevented the driver from enduring contact with hard surface components, thus limiting the severity and extent of his injuries. It is certain that in the absence of manual restraint usage or supplemental restraint deployment in this crash, the driver would have sustained injuries of far greater significance and severity than the AIS 1 injuries he received.

Post-crash, the driver exited the GMC and was evaluated at the scene by EMS personnel. He was placed on an ambulance stretcher and transported to a local hospital for treatment. The driver was treated and released within hours of the crash.

2010 RAM 1500

Description

The other vehicle in this crash was a 2010 RAM pickup truck. This vehicle sustained only minimal damage in the crash and was driven from the scene by its owner. It could not be located for SCI inspection. According to the PAR, the RAM was identified by the VIN: 1D7RB1CT2ASxxxxxx. Based on the VIN, the RAM was a 1500 series conventional cab pickup truck, powered by a 5.7-liter gasoline engine with rear wheel drive. Specification listed the RAM as equipped with CAC frontal air bags for the driver and front row right occupant positions.

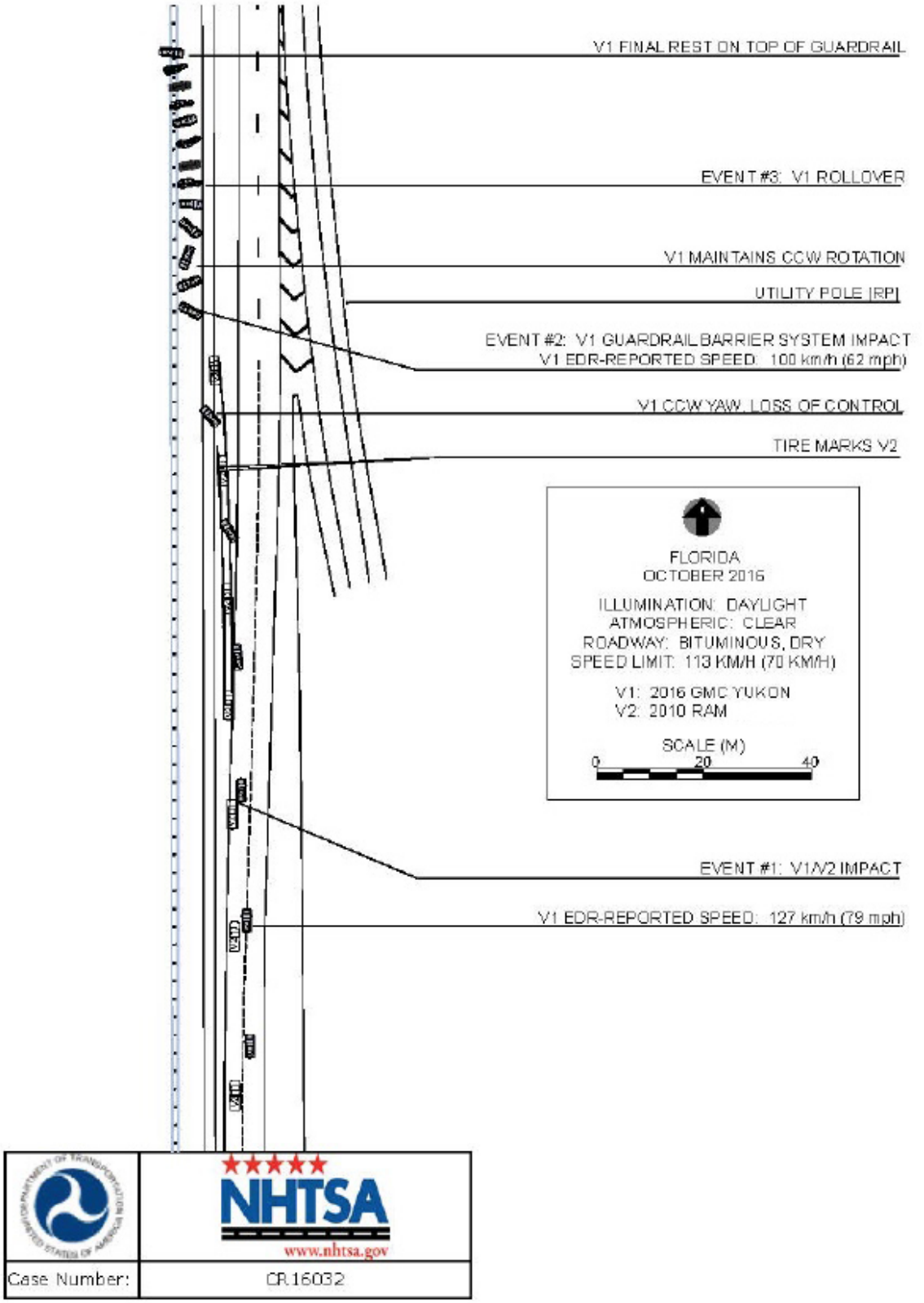
Exterior Damage

The RAM sustained police-reported non-disabling damage to the front right corner area of the vehicle. The frontal air bag system did not deploy and the vehicle did not require towing from the scene of the crash.

Occupant Data

The 40-year-old male driver of the RAM was police-reported as restrained by the manual seat belt system. He was not injured in the crash.

CRASH DIAGRAM



APPENDIX A:
2016 GMC Yukon Event Data Recorder Report[2]

[2] 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	1GKS1CKJ9GR******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	201650S1CR16032_V1_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 17.0
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 17.6.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Deployment, Deployment, Deployment

Comments

No comments entered.

Data Limitations

Recorded Crash Events:

There are two types of recorded crash events for Front, Side, and Rear (FSR) 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 [8 km/h]. A Non-Deployment Event contains Pre-Crash and Crash data. The oldest Non-Deployment event can be overwritten by a Deployment Event, if all three records are full and the Non-Deployment Event is not locked. A Non-Deployment Event can be overwritten by a more recent Non-Deployment Event if all three records are full and the Non-Deployment is older than approximately 250 ignition cycles. Also, a Non-Deployment event can be recorded if one of the following occurs without the Deployment of any of the frontal air bags, side air bags, or roll bars:

-Pretensioner(s) only Deployment
-Head Rest Deployment
-Battery Cut-Off Deployment

The second type of SDM recorded crash event for FSR Events is the Deployment Event. It also contains Pre-Crash and Crash data. Deployment Events cannot be overwritten or cleared by the SDM.
Rollover Events contains Pre-Crash and Crash data. Rollover event follow the same rules as FSR Deployment events.
The SDM can store up to three Events.

Data:

For FSR Events, 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 and Non-Deployment Events, the SDM will record up to 300 milliseconds of data after time zero. The SDM will also record up to 300 milliseconds of Vehicle Acceleration data after time zero.
For Rollover Events, the SDM may record Lateral Acceleration, Vertical Acceleration, and Roll Rate data, if the SDM is rollover capable. This data reflects what the sensing system experienced during the recorded portion of the event. For Rollover Deployment Events, the SDM will record up to 700 milliseconds of data before the Deployment criteria is met and 290 milliseconds after the Deployment criteria is met.
-Deployment loops may be displayed as being deployed in a Non-Deployment event record, if a Deployment event is qualified during the Non-Deployment event. That is, if two or more events are occurring at the same time and one is a Non-Deployment event and one of the others is a Deployment event, and the Deployment event is qualified while the Non-Deployment is still active, the deployed loops may be recorded in the Non-Deployment event record.
-Time between events is recorded in 10 msec intervals and is displayed in seconds for a maximum time of 655.33 seconds. The counter measures the time from the start of one event to the start of the next event if both events occur within the same ignition cycle.
-The Maximum SDM Recorded Vehicle Velocity Change may occur between the recorded 10 millisecond sample points of the SDM Recorded Vehicle Velocity Change. The SDM will only record Maximum SDM Recorded Vehicle Velocity Change for the first 300 milliseconds of the event.
-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 0.5 second Pre-crash data value (most recent recorded data point) is the data point last sampled before Time Zero. That is to say, the last data point may have been captured just before Time Zero but no more than 0.5 second before Time Zero. 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
-Pre-Crash Electronic Data Validity Check Status indicates "Data Not Available" if:
    -No data is received from the module sending the pre-crash data
-For diesel powered vehicles, the data displayed as Throttle Position (%) is actually the data for the Air Inlet Flap Position. This is not the same as the throttle position for a gasoline powered engines.
-Belt Switch Circuit Status indicates the status of the seat belt switch circuit.
-The ignition cycle counter will increment when the power mode cycles from OFF/Accessory to RUN. Applying and removing of battery power to the module will not increment the ignition cycle counter.
-Ignition Cycles Since DTCs Were Last Cleared can record a maximum value of 253 cycles and can only be reset by a scan tool.
-Dynamic Deployment Event Counter tracks the number of Deployment events that have occurred during the SDM's lifetime.
-Dynamic Event Counter tracks the number of qualified events (either Deployments, Non-deploy, or Rollover events) that have occurred during the SDM's lifetime.
-For Deployment Events, DTC B0052 (Deployment commanded) shall be recorded with the remainder of the data for this event even though it occurred after Event Enable.
-Once a firing loop has been commanded to be deployed, it will not be commanded to be deployed again during the same ignition cycle. Firing loop times for subsequent deployment type events, during the same ignition cycle, will record the deployment times as N/A.
-In an event where the module is operating on energy reserve, the Dynamic counters may report a value that is less than the actual value. If the stored values in the Dynamic counters are less than the counter values in the event records or if more than one event record has the same counter value as another, the module may have been operating on its energy reserve.
-The GM parameter name is displayed in parentheses after the NHTSA Part 563 parameter name.
-The reported range of the longitudinal and lateral acceleration values is approximately ± 50 g.
-Due to a CDR Tool data imaging issue, all CDR files imaged from SDM-30 Delphi airbag control modules (ACM) using version 17.6 software are invalid and the ACM must be re-imaged using CDR version 17.6.1 and later software.
-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 by the Body Control Module, 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 Acceleration	Forward
Longitudinal Velocity Change	Forward
Lateral Acceleration	Left to Right
Lateral Velocity Change	Left to Right
Vertical Acceleration	Downward
Roll Rate	Clockwise 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.

01050_SDM30-delphi_r015

System Status at Time of Retrieval

Dynamic Deployment Event Counter	3
Multi-Event, Number of Events (Dynamic Event Counter)	9
Dynamic OnStar Notification Event Counter	6
Vehicle Identification Number (VIN)	1GKS1CKJ9GR******
Ignition Cycle, Download (Ignition Cycles at Investigation)	1077
End Model Part Number	00CF6F2D
System Type	N/A
Software Module Identifier 1	00CF6F21
Software Module Identifier 2	016682B0
Software Module Identifier 3	01621D42
Manufacturing Traceability Data, LineID	K
Manufacturing Traceability Data, ShiftID	1
Manufacturing Traceability Data, Year	15
Manufacturing Traceability Data, DayOfTheYear	303
Manufacturing Traceability Data, Serial/Lot/BatchNumber	390KZ8E00
ESS # 1 Traceability Data, Component Identifier	AU
ESS # 1 Traceability Data, Part Number/Broadcast Code	8677
ESS # 1 Traceability Data, Supplier Code	D
ESS # 1 Traceability Data, Traceability Number	P00000000
ESS # 2 Traceability Data, Component Identifier	AT
ESS # 2 Traceability Data, Part Number/Broadcast Code	8677
ESS # 2 Traceability Data, Supplier Code	D
ESS # 2 Traceability Data, Traceability Number	P00000000
ESS # 3 Traceability Data, Component Identifier	AH
ESS # 3 Traceability Data, Part Number/Broadcast Code	8676
ESS # 3 Traceability Data, Supplier Code	D
ESS # 3 Traceability Data, Traceability Number	A00000000
ESS # 4 Traceability Data, Component Identifier	AJ
ESS # 4 Traceability Data, Part Number/Broadcast Code	8676
ESS # 4 Traceability Data, Supplier Code	D
ESS # 4 Traceability Data, Traceability Number	A00000000
ESS # 5 Traceability Data, Component Identifier	DA
ESS # 5 Traceability Data, Part Number/Broadcast Code	8678
ESS # 5 Traceability Data, Supplier Code	D
ESS # 5 Traceability Data, Traceability Number	A00000000
ESS # 6 Traceability Data, Component Identifier	DB
ESS # 6 Traceability Data, Part Number/Broadcast Code	8678
ESS # 6 Traceability Data, Supplier Code	D
ESS # 6 Traceability Data, Traceability Number	A00000000
ESS # 7 Traceability Data, Component Identifier	??
ESS # 7 Traceability Data, Part Number/Broadcast Code	0000
ESS # 7 Traceability Data, Supplier Code	D
ESS # 7 Traceability Data, Traceability Number	A00000000
ESS # 8 Traceability Data, Component Identifier	??
ESS # 8 Traceability Data, Part Number/Broadcast Code	0000
ESS # 8 Traceability Data, Supplier Code	D
ESS # 8 Traceability Data, Traceability Number	A00000000

System Status at Event (Event Record 1)

Event Record Type	Deployment
OnStar Deployment Status Data Sent	Yes
Complete file recorded (Event Recording Complete)	Yes
Crash Record Locked	Yes
OnStar SDM Recorded Vehicle Velocity Change Data Sent	Yes
Deployment Event Counter	1
Multi-Event, Number of Events (Event Counter)	1
OnStar Notification Event Counter	1
Time From Event 1 to 2 (Time Between Events) (seconds)	Data Not Available
Ignition Cycle, Crash (Ignition Cycles at Event)	1076
Algorithm Active: Frontal	Yes
Algorithm Active: Side	Yes
Algorithm Active: Rollover	Yes
Algorithm Active: Rear	Yes
Concurrent Event Flag Set	No
Event Severity Status: Frontal Pretensioner	Yes
Event Severity Status: Frontal Stage 1	Yes
Event Severity Status: Frontal Stage 2	No
Event Severity Status: Left Side	No
Event Severity Status: Right Side	No
Event Severity Status: Rear	No
Event Severity Status: Rollover	No
Safety Belt Status, Driver (Driver Belt Switch Circuit Status)	Buckled
Safety Belt Status, Right Front Passenger (Passenger Belt Switch Circuit Status)	Not Buckled
Center Front Row Belt Switch Circuit Status (If Equipped)	Data Not Available
Left Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Center Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Right Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Seat Track Position Switch, Foremost, Status, Driver (Driver Seat Position Status)	No (Rearward)
Passenger Seat Occupancy Status	Empty
Occupant Size Right Front Passenger Child (Passenger Classification Status)	No (Not Applicable)
Passenger Air Bag ON Indicator Status	Off
Passenger Air Bag OFF Indicator Status	On
Low Tire Pressure Warning Lamp Status 0.5 Seconds Prior to Time Zero	Off
Frontal Air Bag Warning Lamp (SIR Warning Lamp Status 0.5 Seconds Prior to Time Zero)	Off
SIR Warning Lamp ON/OFF Time Continuously (seconds)	655330
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	1051
Ignition Cycles Since DTCs Were Last Cleared 0.5 Seconds Prior to Time Zero	253
Maximum Delta-V, Longitudinal (Maximum Longitudinal SDM Recorded Vehicle Velocity Change for FSR Event) MPH [km/h]	-11 [-18]
Time, Maximum Delta-V (Time From FSR Time Zero to Maximum Longitudinal SDM Recorded Vehicle Velocity Change)(msec)	298
Maximum Delta-V, Lateral (Maximum Lateral SDM Recorded Vehicle Velocity Change for FSR Event) MPH [km/h]	3 [5]
Time Maximum Delta-V, Lateral (Time From FSR Time Zero to Maximum Lateral SDM Recorded Vehicle Velocity Change)(msec)	180
High Voltage Disable Notification Sent	Yes
Deployment Commanded in Energy Reserve Mode	No

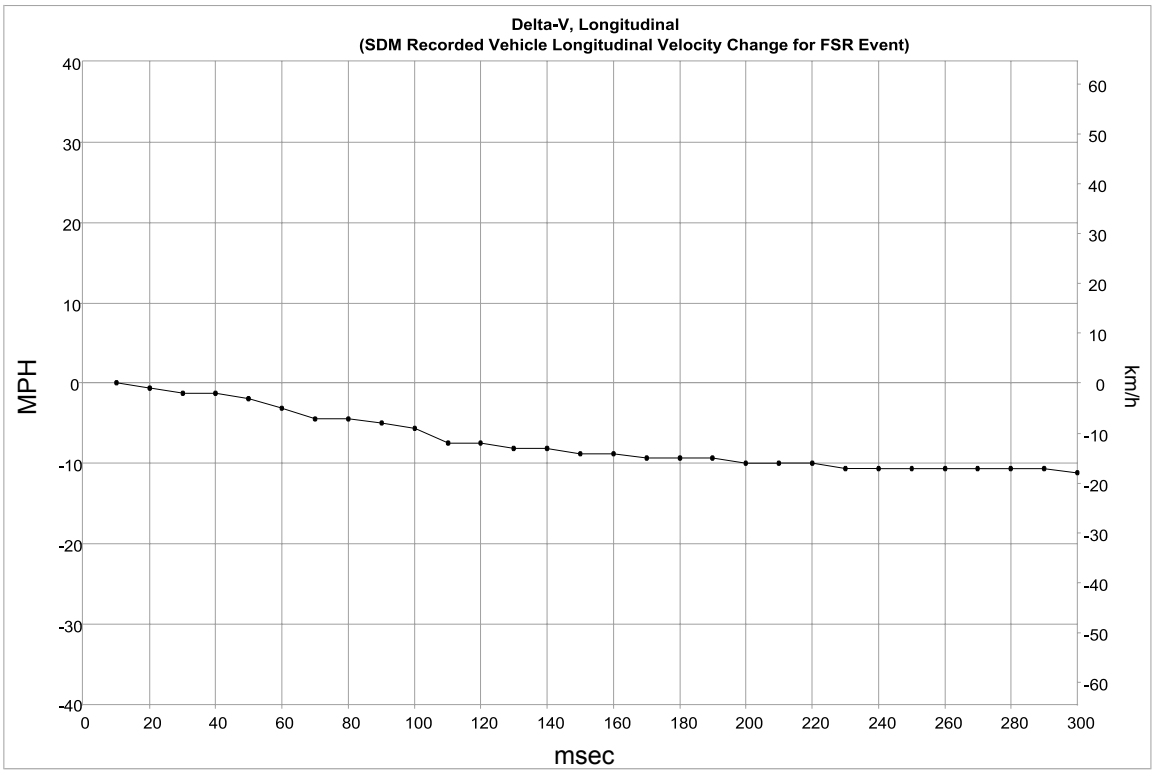
DTCs Present at Time of Event (Event Record 1)

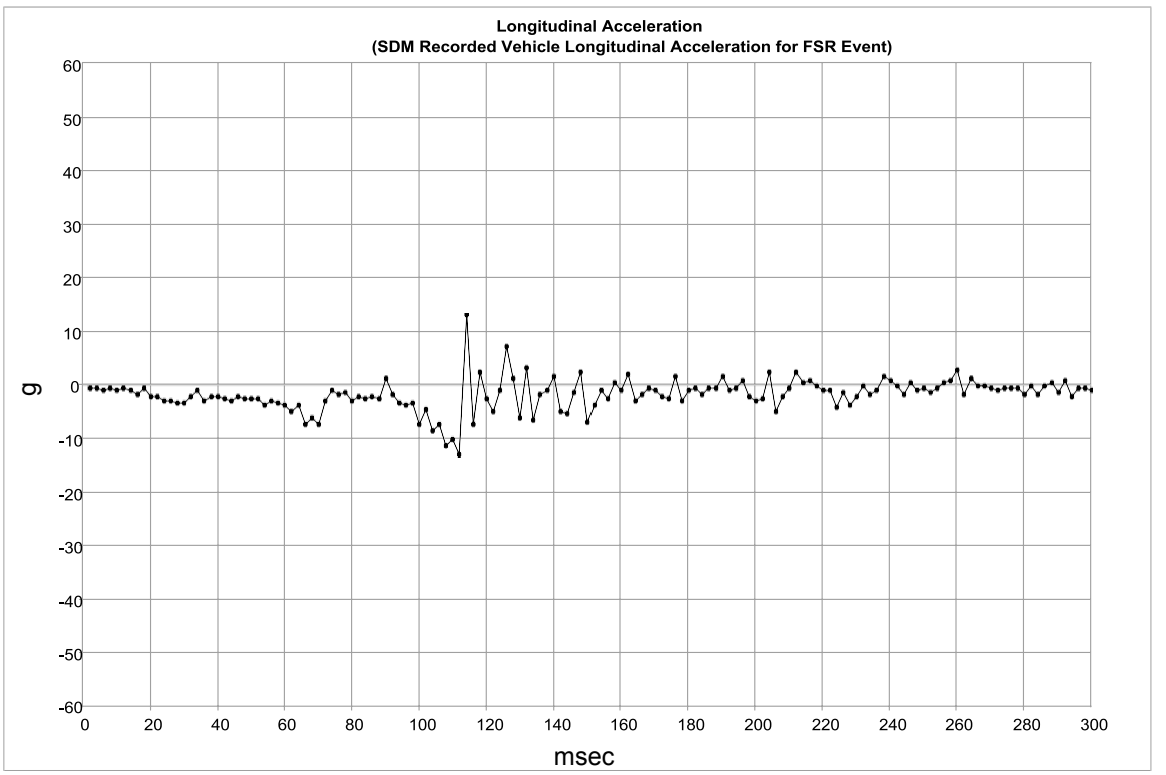
B0052-00

Event Data (Event Record 1)

Driver 1st Stage Deployment Loop Commanded	Yes
Passenger 1st Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded	Yes
Passenger 2nd Stage Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop #1 Commanded	Yes
Passenger Pretensioner Deployment Loop #1 Commanded	Yes
Driver Pretensioner Deployment Loop #2 Commanded	Yes
Passenger Pretensioner Deployment Loop #2 Commanded	Yes
Driver Thorax Loop Commanded	No
Passenger Thorax Loop Commanded	No
Left Row 1 Roof Rail/Head Curtain Loop Commanded	No
Right Row 1 Roof Rail/Head Curtain Loop Commanded	No
Driver Center Inboard Loop Commanded	No
Frontal Air Bag Deployment, Time to 1st Stage Deployment, Driver (Driver 1st Stage Time From Time Zero to Deployment Command Criteria Met)(msec)	66
Frontal Air Bag Deployment, Time to 2nd Stage, Driver (Driver 2nd Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	189
Frontal Air Bag Deployment, Time to 1st Stage Deployment, Right Front Passenger (Passenger 1st Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Frontal Air Bag Deployment, Time to 2nd Stage, Right Front Passenger (Passenger 2nd Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Side air bag deployment, time to deploy, driver (Driver Thorax/Curtain Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Side air bag deployment, time to deploy, right front passenger (Passenger Thorax/Curtain Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Pretensioner Deployment, Time to Fire, Driver (Driver Pretensioner Time From Time Zero to Deployment Loop #1 or Loop #2 Command Criteria Met) (msec)	66
Pretensioner Deployment, Time to Fire, Right Front Passenger (Passenger Pretensioner Time From Time Zero to Deployment Loop #1 or Loop #2 Command Criteria Met) (msec)	66

Longitudinal Crash Pulse (Event Record 1)





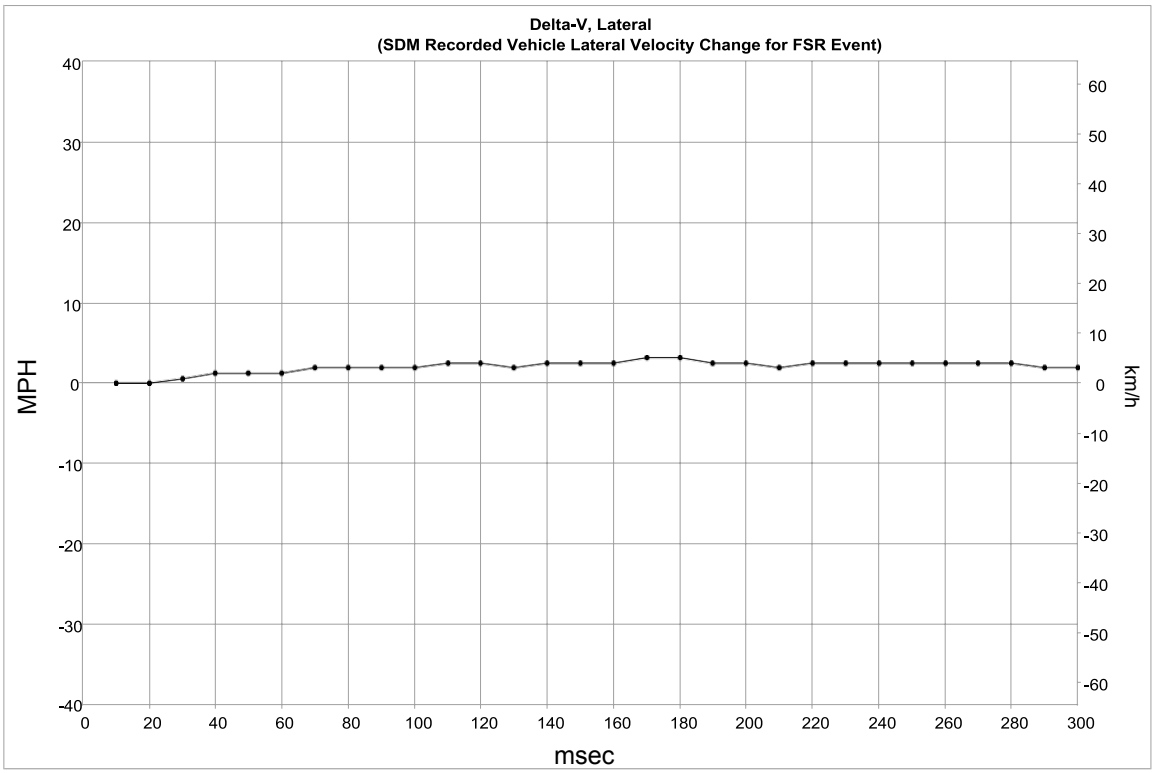
Longitudinal Crash Pulse (Event Record 1)

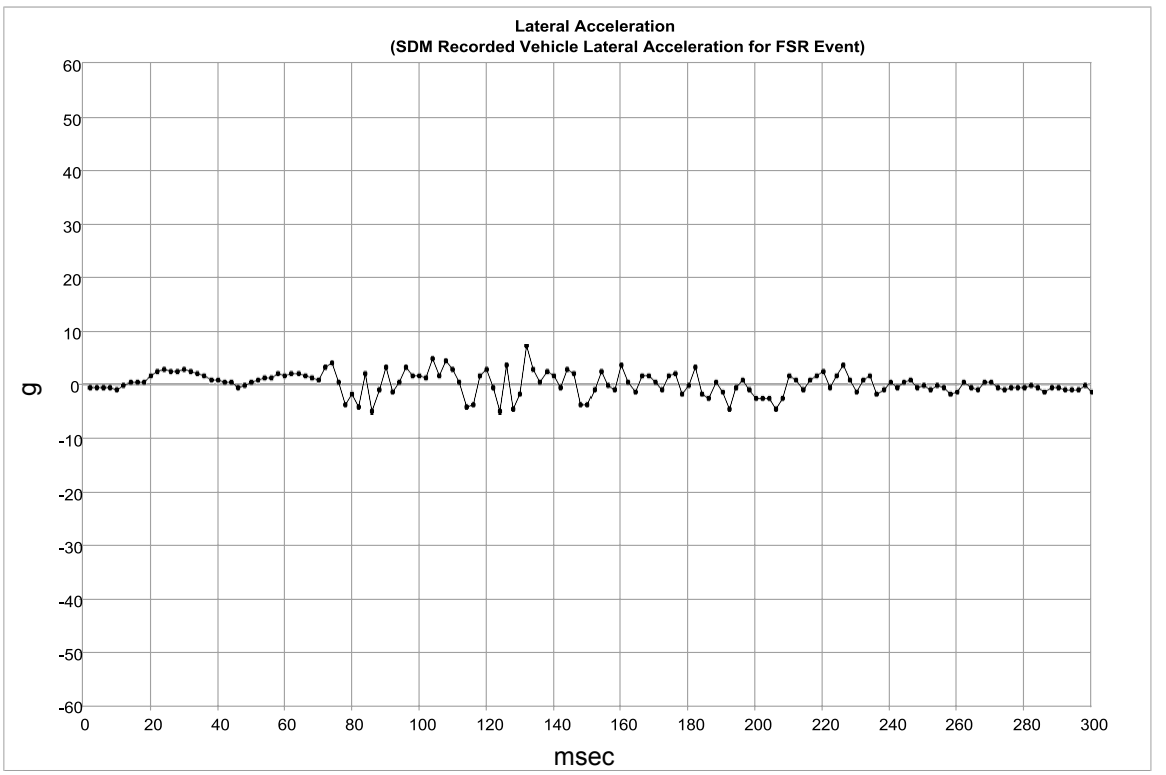
Time (msec)	Delta-V, Longitudinal (SDM Recorded Vehicle Longitudinal Velocity Change for FSR Event) (MPH)	Delta-V, Longitudinal (SDM Recorded Vehicle Longitudinal Velocity Change for FSR Event) (km/h)
10	0.0	0.0
20	-0.6	-1.0
30	-1.2	-2.0
40	-1.2	-2.0
50	-1.9	-3.0
60	-3.1	-5.0
70	-4.3	-7.0
80	-4.3	-7.0
90	-5.0	-8.0
100	-5.6	-9.0
110	-7.5	-12.0
120	-7.5	-12.0
130	-8.1	-13.0
140	-8.1	-13.0
150	-8.7	-14.0
160	-8.7	-14.0
170	-9.3	-15.0
180	-9.3	-15.0
190	-9.3	-15.0
200	-9.9	-16.0
210	-9.9	-16.0
220	-9.9	-16.0
230	-10.6	-17.0
240	-10.6	-17.0
250	-10.6	-17.0
260	-10.6	-17.0
270	-10.6	-17.0
280	-10.6	-17.0
290	-10.6	-17.0
300	-11.2	-18.0

Longitudinal Crash Pulse (Event Record 1)

Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event) (g)	Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event) (g)	Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event) (g)
2	-0.6	102	-4.6	202	-2.6
4	-0.6	104	-8.6	204	2.2
6	-1.0	106	-7.4	206	-5.0
8	-0.6	108	-11.4	208	-2.2
10	-1.0	110	-10.2	210	-0.6
12	-0.6	112	-13.0	212	2.2
14	-1.0	114	13.0	214	0.2
16	-1.8	116	-7.4	216	0.6
18	-0.6	118	2.2	218	-0.2
20	-2.2	120	-2.6	220	-1.0
22	-2.2	122	-5.0	222	-1.0
24	-3.0	124	-1.0	224	-4.2
26	-3.0	126	7.0	226	-1.4
28	-3.4	128	1.0	228	-3.8
30	-3.4	130	-6.2	230	-2.2
32	-2.2	132	3.0	232	-0.2
34	-1.0	134	-6.6	234	-1.8
36	-3.0	136	-1.8	236	-1.0
38	-2.2	138	-1.0	238	1.4
40	-2.2	140	1.4	240	0.6
42	-2.6	142	-5.0	242	-0.2
44	-3.0	144	-5.4	244	-1.8
46	-2.2	146	-1.4	246	0.2
48	-2.6	148	2.2	248	-1.0
50	-2.6	150	-7.0	250	-0.6
52	-2.6	152	-3.8	252	-1.4
54	-3.8	154	-1.0	254	-0.6
56	-3.0	156	-2.6	256	0.2
58	-3.4	158	0.2	258	0.6
60	-3.8	160	-1.0	260	2.6
62	-5.0	162	1.8	262	-1.8
64	-3.8	164	-3.0	264	1.0
66	-7.4	166	-1.8	266	-0.2
68	-6.2	168	-0.6	268	-0.2
70	-7.4	170	-1.0	270	-0.6
72	-3.0	172	-2.2	272	-1.0
74	-1.0	174	-2.6	274	-0.6
76	-1.8	176	1.4	276	-0.6
78	-1.4	178	-3.0	278	-0.6
80	-3.0	180	-1.0	280	-1.8
82	-2.2	182	-0.6	282	-0.2
84	-2.6	184	-1.8	284	-1.8
86	-2.2	186	-0.6	286	-0.2
88	-2.6	188	-0.6	288	0.2
90	1.0	190	1.4	290	-1.4
92	-1.8	192	-1.0	292	0.6
94	-3.4	194	-0.6	294	-2.2
96	-3.8	196	0.6	296	-0.6
98	-3.4	198	-2.2	298	-0.6
100	-7.4	200	-3.0	300	-1.0

Lateral Crash Pulse (Event Record 1)





Lateral Crash Pulse (Event Record 1)

Time (msec)	Delta-V, Lateral (SDM Recorded Vehicle Lateral Velocity Change for FSR Event) (MPH)	Delta-V, Lateral (SDM Recorded Vehicle Lateral Velocity Change for FSR Event) (km/h)
10	0.0	0.0
20	0.0	0.0
30	0.6	1.0
40	1.2	2.0
50	1.2	2.0
60	1.2	2.0
70	1.9	3.0
80	1.9	3.0
90	1.9	3.0
100	1.9	3.0
110	2.5	4.0
120	2.5	4.0
130	1.9	3.0
140	2.5	4.0
150	2.5	4.0
160	2.5	4.0
170	3.1	5.0
180	3.1	5.0
190	2.5	4.0
200	2.5	4.0
210	1.9	3.0
220	2.5	4.0
230	2.5	4.0
240	2.5	4.0
250	2.5	4.0
260	2.5	4.0
270	2.5	4.0
280	2.5	4.0
290	1.9	3.0
300	1.9	3.0

Lateral Crash Pulse (Event Record 1)

Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)	Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)	Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)
2	-0.6	102	1.0	202	-2.6
4	-0.6	104	4.6	204	-2.6
6	-0.6	106	1.4	206	-4.6
8	-0.6	108	4.2	208	-2.6
10	-1.0	110	2.6	210	1.4
12	-0.2	112	0.2	212	0.6
14	0.2	114	-4.2	214	-1.0
16	0.2	116	-3.8	216	0.6
18	0.2	118	1.4	218	1.4
20	1.4	120	2.6	220	2.2
22	2.2	122	-0.6	222	-0.6
24	2.6	124	-5.0	224	1.4
26	2.2	126	3.4	226	3.4
28	2.2	128	-4.6	228	0.6
30	2.6	130	-1.8	230	-1.4
32	2.2	132	7.0	232	0.6
34	1.8	134	2.6	234	1.4
36	1.4	136	0.2	236	-1.8
38	0.6	138	2.2	238	-1.0
40	0.6	140	1.4	240	0.2
42	0.2	142	-0.6	242	-0.6
44	0.2	144	2.6	244	0.2
46	-0.6	146	1.8	246	0.6
48	-0.2	148	-3.8	248	-0.6
50	0.2	150	-3.8	250	-0.2
52	0.6	152	-1.0	252	-1.0
54	1.0	154	2.2	254	-0.2
56	1.0	156	-0.2	256	-0.6
58	1.8	158	-1.0	258	-1.8
60	1.4	160	3.4	260	-1.4
62	1.8	162	0.2	262	0.2
64	1.8	164	-1.4	264	-0.6
66	1.4	166	1.4	266	-1.0
68	1.0	168	1.4	268	0.2
70	0.6	170	0.2	270	0.2
72	3.0	172	-1.0	272	-0.6
74	3.8	174	1.4	274	-1.0
76	0.2	176	1.8	276	-0.6
78	-3.8	178	-1.8	278	-0.6
80	-1.8	180	-0.2	280	-0.6
82	-4.2	182	3.0	282	-0.2
84	1.8	184	-1.8	284	-0.6
86	-5.0	186	-2.6	286	-1.4
88	-1.0	188	0.2	288	-0.6
90	3.0	190	-1.4	290	-0.6
92	-1.4	192	-4.6	292	-1.0
94	0.2	194	-0.6	294	-1.0
96	3.0	196	0.6	296	-1.0
98	1.4	198	-1.0	298	-0.2
100	1.4	200	-2.6	300	-1.4

Rollover Crash Pulse (Event Record 1)
SDM Recorded Vehicle Roll Rate

Contains No Recorded Data

Rollover Crash Pulse (Event Record 1)
Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for Rollover Event)

Contains No Recorded Data

Vertical Crash Pulse (Event Record 1)
Normal Acceleration (SDM Recorded Vehicle Vertical Acceleration for Rollover Event)

Contains No Recorded Data

Pre-Crash Data -5.0 to -0.5 sec (Event Record 1)

Times (sec)	Accelerator Pedal, % Full (Accelerator Pedal Position)	Service Brake (Brake Switch Circuit State)	Engine RPM (Engine Speed)	Engine Throttle, % Full (Throttle Position)	Speed, Vehicle Indicated (Vehicle Speed) (MPH [km/h])
-5.0	0	On	1728	11	79 [127]
-4.5	26	Off	1728	23	78 [126]
-4.0	11	Off	1856	35	78 [126]
-3.5	30	Off	1792	35	79 [127]
-3.0	10	Off	1728	29	79 [127]
-2.5	21	Off	1728	23	78 [126]
-2.0	67	Off	2432	84	78 [125]
-1.5	12	On	2624	32	75 [121]
-1.0	0	On	2240	19	66 [106]
-0.5	0	On	1792	15	62 [100]

Pre-Crash Data -2.0 to -0.5 sec (Event Record 1)

Times (sec)	Cruise Control Active	Cruise Control Resume Switch Active	Cruise Control Set Switch Active	Engine Torque (lb-ft [N-m])	Reduced Engine Power Mode Indicator
-2.0	No	No	No	330 [448]	Off
-1.5	No	No	No	138 [187]	Off
-1.0	No	No	No	15 [20]	Off
-0.5	No	No	No	6 [8]	Off

System Status at Event (Event Record 2)

Event Record Type	Deployment
OnStar Deployment Status Data Sent	No
Complete file recorded (Event Recording Complete)	Yes
Crash Record Locked	Yes
OnStar SDM Recorded Vehicle Velocity Change Data Sent	No
Deployment Event Counter	2
Multi-Event, Number of Events (Event Counter)	2
OnStar Notification Event Counter	2
Time From Event 1 to 2 (Time Between Events) (seconds)	0.04
Ignition Cycle, Crash (Ignition Cycles at Event)	1076
Algorithm Active: Frontal	Yes
Algorithm Active: Side	Yes
Algorithm Active: Rollover	Yes
Algorithm Active: Rear	Yes
Concurrent Event Flag Set	No
Event Severity Status: Frontal Pretensioner	No
Event Severity Status: Frontal Stage 1	No
Event Severity Status: Frontal Stage 2	No
Event Severity Status: Left Side	No
Event Severity Status: Right Side	No
Event Severity Status: Rear	No
Event Severity Status: Rollover	Yes
Safety Belt Status, Driver (Driver Belt Switch Circuit Status)	Buckled
Safety Belt Status, Right Front Passenger (Passenger Belt Switch Circuit Status)	Not Buckled
Center Front Row Belt Switch Circuit Status (If Equipped)	Data Not Available
Left Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Center Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Right Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Seat Track Position Switch, Foremost, Status, Driver (Driver Seat Position Status)	No (Rearward)
Passenger Seat Occupancy Status	Empty
Occupant Size Right Front Passenger Child (Passenger Classification Status)	No (Not Applicable)
Passenger Air Bag ON Indicator Status	Off
Passenger Air Bag OFF Indicator Status	On
Low Tire Pressure Warning Lamp Status 0.5 Seconds Prior to Time Zero	Off
Frontal Air Bag Warning Lamp (SIR Warning Lamp Status 0.5 Seconds Prior to Time Zero)	Off
SIR Warning Lamp ON/OFF Time Continuously (seconds)	655330
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	1051
Ignition Cycles Since DTCs Were Last Cleared 0.5 Seconds Prior to Time Zero	253
Maximum Delta-V, Longitudinal (Maximum Longitudinal SDM Recorded Vehicle Velocity Change for FSR Event) MPH [km/h]	Data Not Available
Time, Maximum Delta-V (Time From FSR Time Zero to Maximum Longitudinal SDM Recorded Vehicle Velocity Change)(msec)	Data Not Available
Maximum Delta-V, Lateral (Maximum Lateral SDM Recorded Vehicle Velocity Change for FSR Event) MPH [km/h]	Data Not Available
Time Maximum Delta-V, Lateral (Time From FSR Time Zero to Maximum Lateral SDM Recorded Vehicle Velocity Change)(msec)	Data Not Available
High Voltage Disable Notification Sent	Yes
Deployment Commanded in Energy Reserve Mode	No

DTCs Present at Time of Event (Event Record 2)

B0052-00

Event Data (Event Record 2)

Driver 1st Stage Deployment Loop Commanded	No
Passenger 1st Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop #1 Commanded	No
Passenger Pretensioner Deployment Loop #1 Commanded	No
Driver Pretensioner Deployment Loop #2 Commanded	No
Passenger Pretensioner Deployment Loop #2 Commanded	No
Driver Thorax Loop Commanded	No
Passenger Thorax Loop Commanded	No
Left Row 1 Roof Rail/Head Curtain Loop Commanded	Yes
Right Row 1 Roof Rail/Head Curtain Loop Commanded	Yes
Driver Center Inboard Loop Commanded	Yes
Frontal Air Bag Deployment, Time to 1st Stage Deployment, Driver (Driver 1st Stage Time From Time Zero to Deployment Command Criteria Met)(msec)	Data Not Available
Frontal Air Bag Deployment, Time to 2nd Stage, Driver (Driver 2nd Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Frontal Air Bag Deployment, Time to 1st Stage Deployment, Right Front Passenger (Passenger 1st Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Frontal Air Bag Deployment, Time to 2nd Stage, Right Front Passenger (Passenger 2nd Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Side air bag deployment, time to deploy, driver (Driver Thorax/Curtain Time From Time Zero to Deployment Command Criteria Met) (msec)	253
Side air bag deployment, time to deploy, right front passenger (Passenger Thorax/Curtain Time From Time Zero to Deployment Command Criteria Met) (msec)	253
Pretensioner Deployment, Time to Fire, Driver (Driver Pretensioner Time From Time Zero to Deployment Loop #1 or Loop #2 Command Criteria Met) (msec)	Data Not Available
Pretensioner Deployment, Time to Fire, Right Front Passenger (Passenger Pretensioner Time From Time Zero to Deployment Loop #1 or Loop #2 Command Criteria Met) (msec)	Data Not Available

Longitudinal Crash Pulse (Event Record 2)
Delta-V, Longitudinal (SDM Recorded Vehicle Longitudinal Velocity Change for FSR Event)

Contains No Recorded Data

Longitudinal Crash Pulse (Event Record 2)
Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event)

Contains No Recorded Data

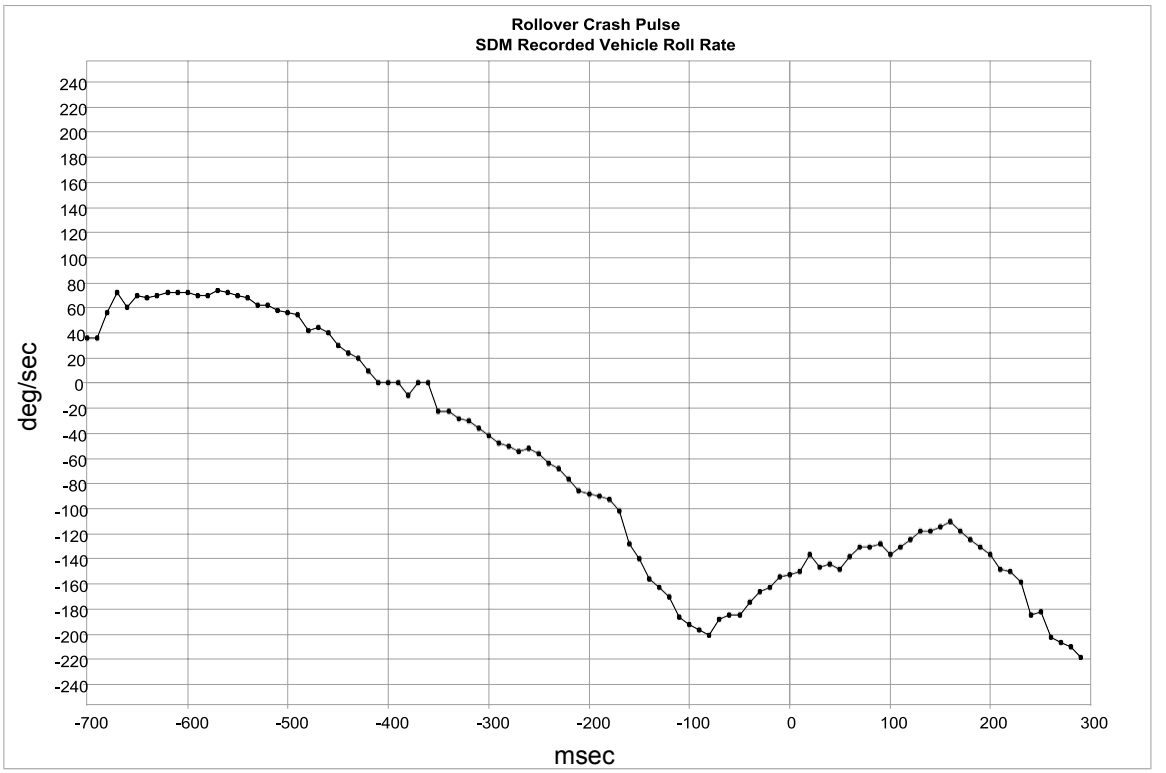
Lateral Crash Pulse (Event Record 2)
Delta-V, Lateral (SDM Recorded Vehicle Lateral Velocity Change for FSR Event)

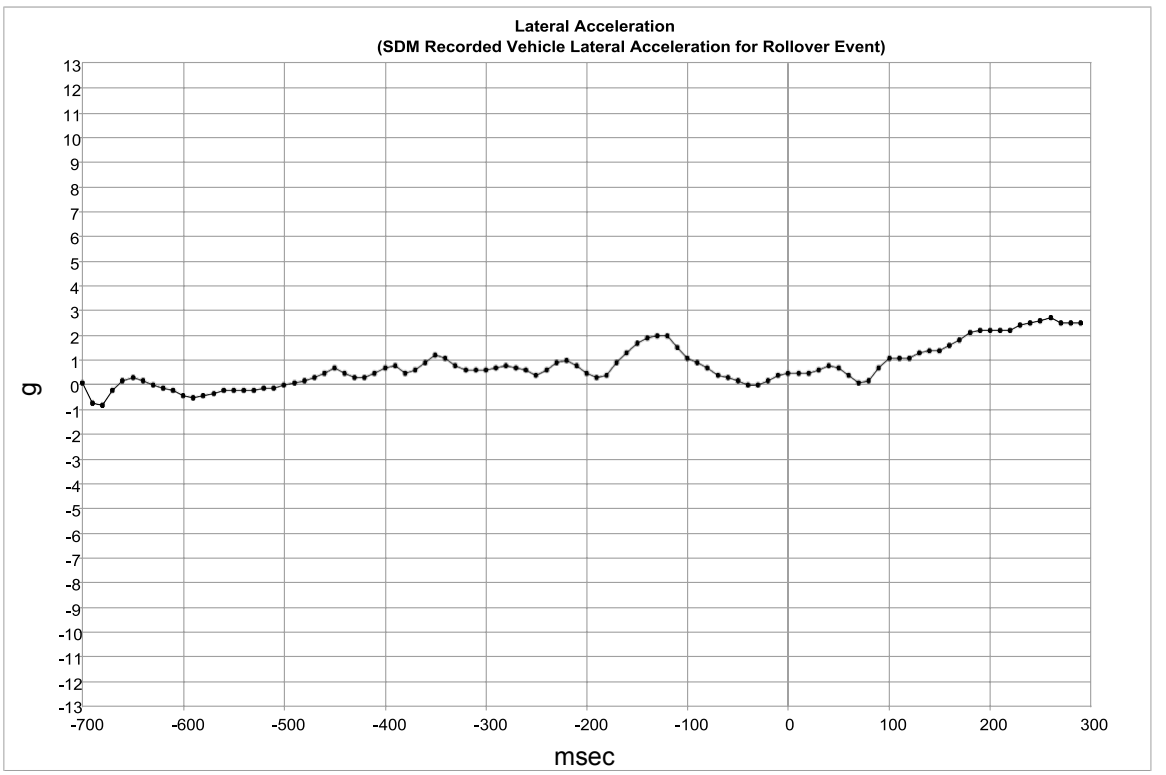
Contains No Recorded Data

Lateral Crash Pulse (Event Record 2)
Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event)

Contains No Recorded Data

Rollover Crash Pulse (Event Record 2)





Rollover Crash Pulse (Event Record 2)

Time (msec)	SDM Recorded Vehicle Roll Rate (deg/sec)	Time (msec)	SDM Recorded Vehicle Roll Rate (deg/sec)
-700	36	-200	-88
-690	36	-190	-90
-680	56	-180	-92
-670	72	-170	-102
-660	60	-160	-128
-650	70	-150	-140
-640	68	-140	-156
-630	70	-130	-162
-620	72	-120	-170
-610	72	-110	-186
-600	72	-100	-192
-590	70	-90	-196
-580	70	-80	-200
-570	74	-70	-188
-560	72	-60	-184
-550	70	-50	-184
-540	68	-40	-174
-530	62	-30	-166
-520	62	-20	-162
-510	58	-10	-154
-500	56	0	-152
-490	54	10	-150
-480	42	20	-136
-470	44	30	-146
-460	40	40	-144
-450	30	50	-148
-440	24	60	-138
-430	20	70	-130
-420	10	80	-130
-410	0	90	-128
-400	0	100	-136
-390	0	110	-130
-380	-10	120	-124
-370	0	130	-118
-360	0	140	-118
-350	-22	150	-114
-340	-22	160	-110
-330	-28	170	-118
-320	-30	180	-124
-310	-36	190	-130
-300	-42	200	-136
-290	-48	210	-148
-280	-50	220	-150
-270	-54	230	-158
-260	-52	240	-184
-250	-56	250	-182
-240	-64	260	-202
-230	-68	270	-206
-220	-76	280	-210
-210	-86	290	-218

Rollover Crash Pulse (Event Record 2)

Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for Rollover Event) (g)	Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for Rollover Event) (g)
-700	0.1	-200	0.5
-690	-0.7	-190	0.3
-680	-0.8	-180	0.4
-670	-0.2	-170	0.9
-660	0.2	-160	1.3
-650	0.3	-150	1.7
-640	0.2	-140	1.9
-630	0.0	-130	2.0
-620	-0.1	-120	2.0
-610	-0.2	-110	1.5
-600	-0.4	-100	1.1
-590	-0.5	-90	0.9
-580	-0.4	-80	0.7
-570	-0.3	-70	0.4
-560	-0.2	-60	0.3
-550	-0.2	-50	0.2
-540	-0.2	-40	0.0
-530	-0.2	-30	0.0
-520	-0.1	-20	0.2
-510	-0.1	-10	0.4
-500	0.0	0	0.5
-490	0.1	10	0.5
-480	0.2	20	0.5
-470	0.3	30	0.6
-460	0.5	40	0.8
-450	0.7	50	0.7
-440	0.5	60	0.4
-430	0.3	70	0.1
-420	0.3	80	0.2
-410	0.5	90	0.7
-400	0.7	100	1.1
-390	0.8	110	1.1
-380	0.5	120	1.1
-370	0.6	130	1.3
-360	0.9	140	1.4
-350	1.2	150	1.4
-340	1.1	160	1.6
-330	0.8	170	1.8
-320	0.6	180	2.1
-310	0.6	190	2.2
-300	0.6	200	2.2
-290	0.7	210	2.2
-280	0.8	220	2.2
-270	0.7	230	2.4
-260	0.6	240	2.5
-250	0.4	250	2.6
-240	0.6	260	2.7
-230	0.9	270	2.5
-220	1.0	280	2.5
-210	0.8	290	2.5

Vertical Crash Pulse (Event Record 2)
Normal Acceleration (SDM Recorded Vehicle Vertical Acceleration for Rollover Event)

Contains No Recorded Data

Pre-Crash Data -5.0 to -0.5 sec (Event Record 2)

Times (sec)	Accelerator Pedal, % Full (Accelerator Pedal Position)	Service Brake (Brake Switch Circuit State)	Engine RPM (Engine Speed)	Engine Throttle, % Full (Throttle Position)	Speed, Vehicle Indicated (Vehicle Speed) (MPH [km/h])
-5.0	0	On	1728	11	79 [127]
-4.5	26	Off	1728	23	78 [126]
-4.0	11	Off	1856	35	78 [126]
-3.5	30	Off	1792	35	79 [127]
-3.0	10	Off	1728	29	79 [127]
-2.5	21	Off	1728	23	78 [126]
-2.0	67	Off	2432	84	78 [125]
-1.5	12	On	2624	32	75 [121]
-1.0	0	On	2240	19	66 [106]
-0.5	0	On	1792	15	62 [100]

Pre-Crash Data -2.0 to -0.5 sec (Event Record 2)

Times (sec)	Cruise Control Active	Cruise Control Resume Switch Active	Cruise Control Set Switch Active	Engine Torque (lb-ft [N-m])	Reduced Engine Power Mode Indicator
-2.0	No	No	No	330 [448]	Off
-1.5	No	No	No	138 [187]	Off
-1.0	No	No	No	15 [20]	Off
-0.5	No	No	No	6 [8]	Off

System Status at Event (Event Record 3)

Event Record Type	Deployment
OnStar Deployment Status Data Sent	Yes
Complete file recorded (Event Recording Complete)	Yes
Crash Record Locked	Yes
OnStar SDM Recorded Vehicle Velocity Change Data Sent	Yes
Deployment Event Counter	3
Multi-Event, Number of Events (Event Counter)	8
OnStar Notification Event Counter	6
Time From Event 1 to 2 (Time Between Events) (seconds)	3.35
Ignition Cycle, Crash (Ignition Cycles at Event)	1076
Algorithm Active: Frontal	Yes
Algorithm Active: Side	Yes
Algorithm Active: Rollover	Yes
Algorithm Active: Rear	Yes
Concurrent Event Flag Set	No
Event Severity Status: Frontal Pretensioner	No
Event Severity Status: Frontal Stage 1	No
Event Severity Status: Frontal Stage 2	No
Event Severity Status: Left Side	Yes
Event Severity Status: Right Side	No
Event Severity Status: Rear	No
Event Severity Status: Rollover	No
Safety Belt Status, Driver (Driver Belt Switch Circuit Status)	Buckled
Safety Belt Status, Right Front Passenger (Passenger Belt Switch Circuit Status)	Not Buckled
Center Front Row Belt Switch Circuit Status (If Equipped)	Data Not Available
Left Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Center Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Right Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Seat Track Position Switch, Foremost, Status, Driver (Driver Seat Position Status)	No (Rearward)
Passenger Seat Occupancy Status	Empty
Occupant Size Right Front Passenger Child (Passenger Classification Status)	No (Not Applicable)
Passenger Air Bag ON Indicator Status	Off
Passenger Air Bag OFF Indicator Status	On
Low Tire Pressure Warning Lamp Status 0.5 Seconds Prior to Time Zero	Off
Frontal Air Bag Warning Lamp (SIR Warning Lamp Status 0.5 Seconds Prior to Time Zero)	On
SIR Warning Lamp ON/OFF Time Continuously (seconds)	0
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	0
Ignition Cycles Since DTCs Were Last Cleared 0.5 Seconds Prior to Time Zero	253
Maximum Delta-V, Longitudinal (Maximum Longitudinal SDM Recorded Vehicle Velocity Change for FSR Event) MPH [km/h]	3 [5]
Time, Maximum Delta-V (Time From FSR Time Zero to Maximum Longitudinal SDM Recorded Vehicle Velocity Change)(msec)	196
Maximum Delta-V, Lateral (Maximum Lateral SDM Recorded Vehicle Velocity Change for FSR Event) MPH [km/h]	7 [12]
Time Maximum Delta-V, Lateral (Time From FSR Time Zero to Maximum Lateral SDM Recorded Vehicle Velocity Change)(msec)	186
High Voltage Disable Notification Sent	Yes
Deployment Commanded in Energy Reserve Mode	No

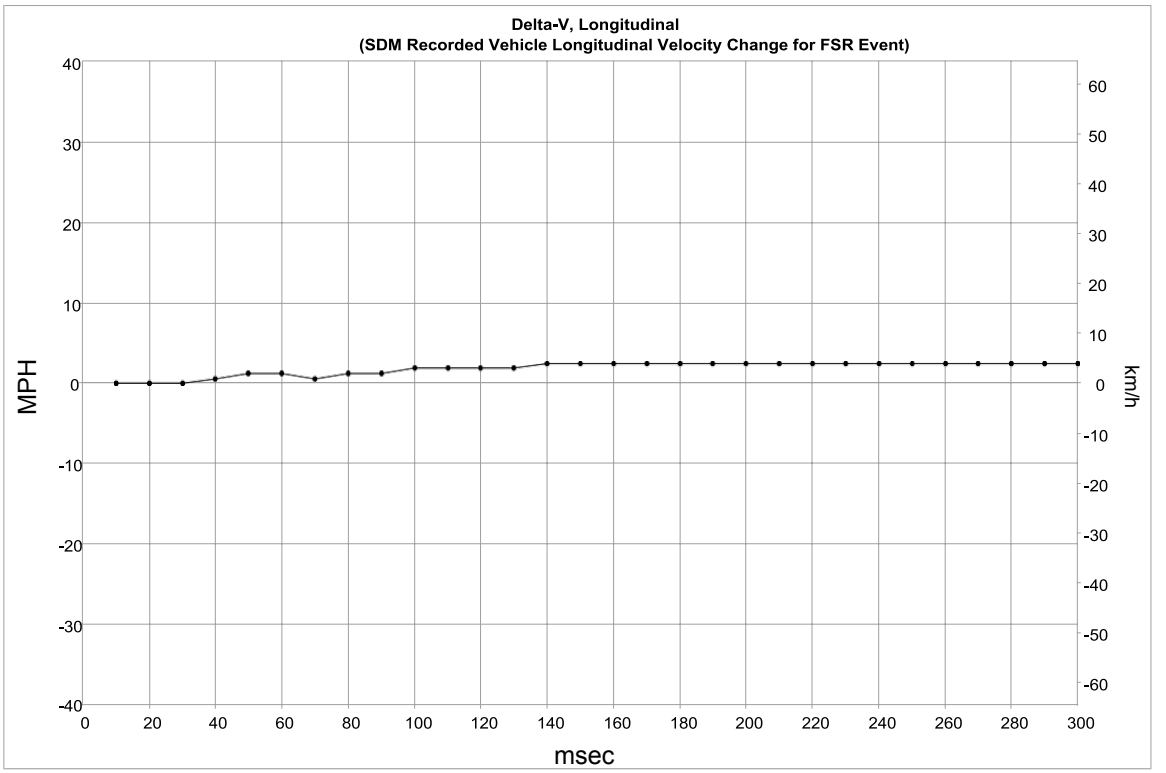
DTCs Present at Time of Event (Event Record 3)

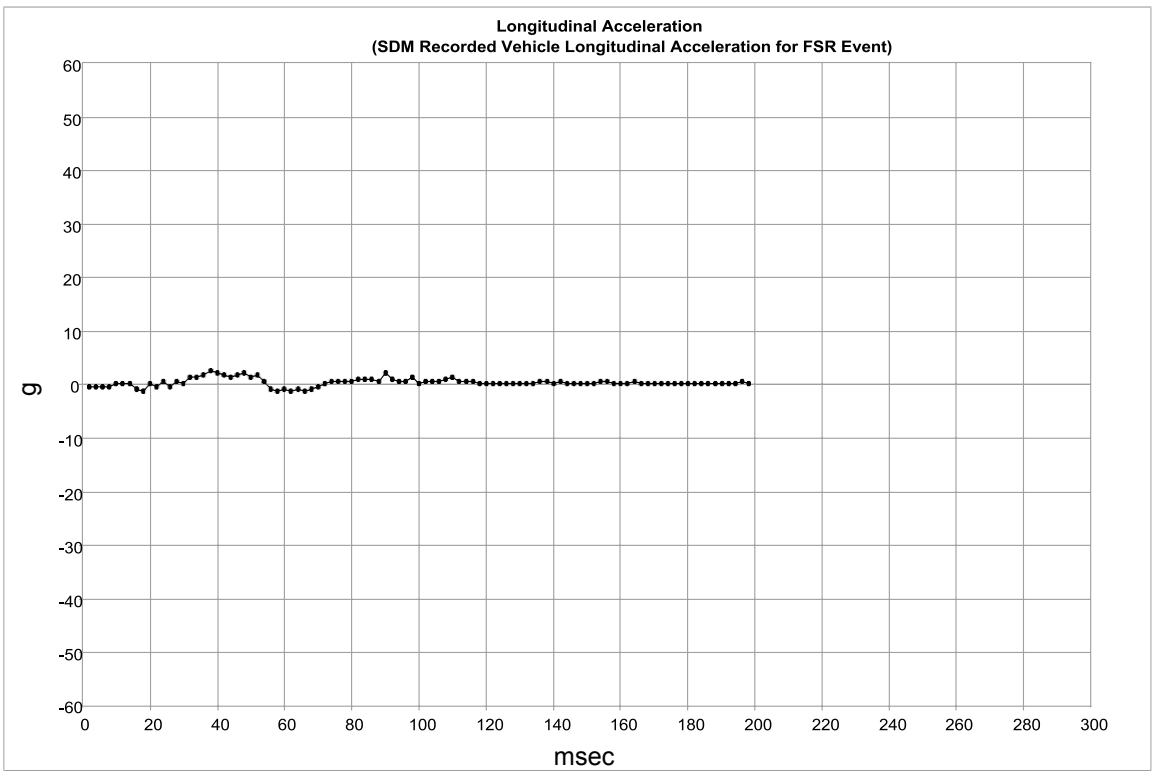
B0052-00

Event Data (Event Record 3)

Driver 1st Stage Deployment Loop Commanded	No
Passenger 1st Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop #1 Commanded	No
Passenger Pretensioner Deployment Loop #1 Commanded	No
Driver Pretensioner Deployment Loop #2 Commanded	No
Passenger Pretensioner Deployment Loop #2 Commanded	No
Driver Thorax Loop Commanded	Yes
Passenger Thorax Loop Commanded	No
Left Row 1 Roof Rail/Head Curtain Loop Commanded	No
Right Row 1 Roof Rail/Head Curtain Loop Commanded	No
Driver Center Inboard Loop Commanded	No
Frontal Air Bag Deployment, Time to 1st Stage Deployment, Driver (Driver 1st Stage Time From Time Zero to Deployment Command Criteria Met)(msec)	Data Not Available
Frontal Air Bag Deployment, Time to 2nd Stage, Driver (Driver 2nd Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Frontal Air Bag Deployment, Time to 1st Stage Deployment, Right Front Passenger (Passenger 1st Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Frontal Air Bag Deployment, Time to 2nd Stage, Right Front Passenger (Passenger 2nd Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Side air bag deployment, time to deploy, driver (Driver Thorax/Curtain Time From Time Zero to Deployment Command Criteria Met) (msec)	11
Side air bag deployment, time to deploy, right front passenger (Passenger Thorax/Curtain Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Pretensioner Deployment, Time to Fire, Driver (Driver Pretensioner Time From Time Zero to Deployment Loop #1 or Loop #2 Command Criteria Met) (msec)	Data Not Available
Pretensioner Deployment, Time to Fire, Right Front Passenger (Passenger Pretensioner Time From Time Zero to Deployment Loop #1 or Loop #2 Command Criteria Met) (msec)	Data Not Available

Longitudinal Crash Pulse (Event Record 3)





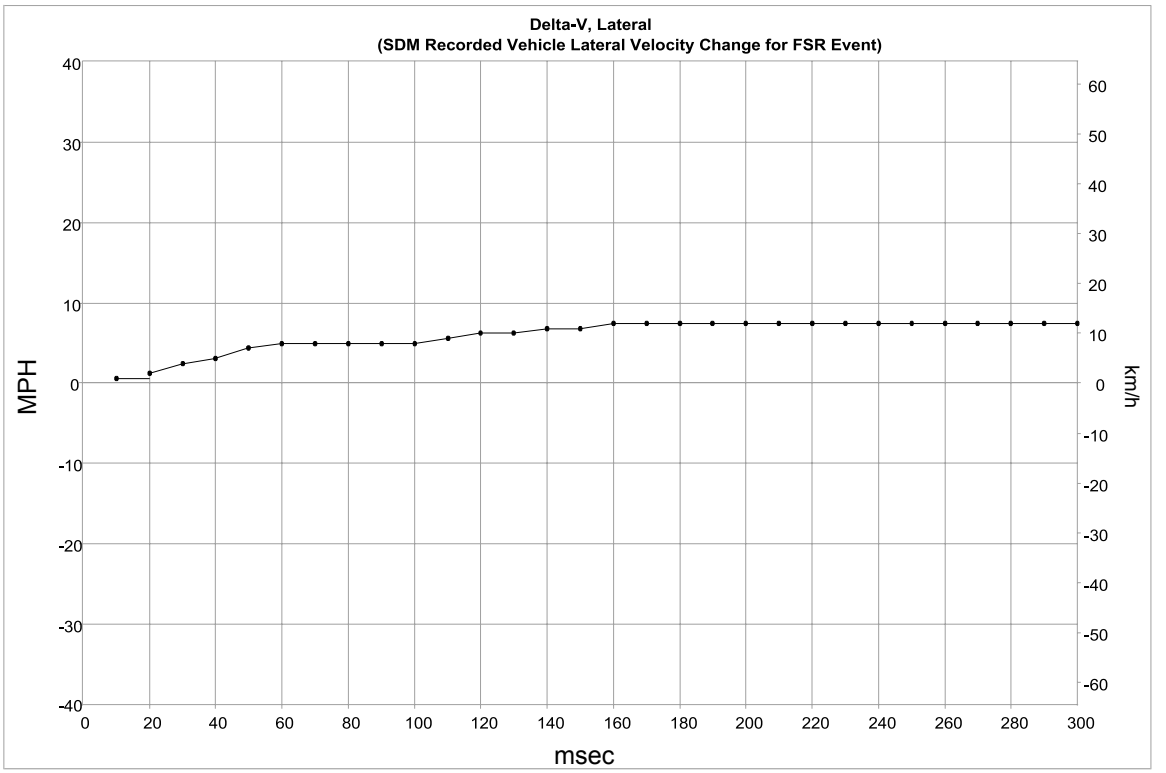
Longitudinal Crash Pulse (Event Record 3)

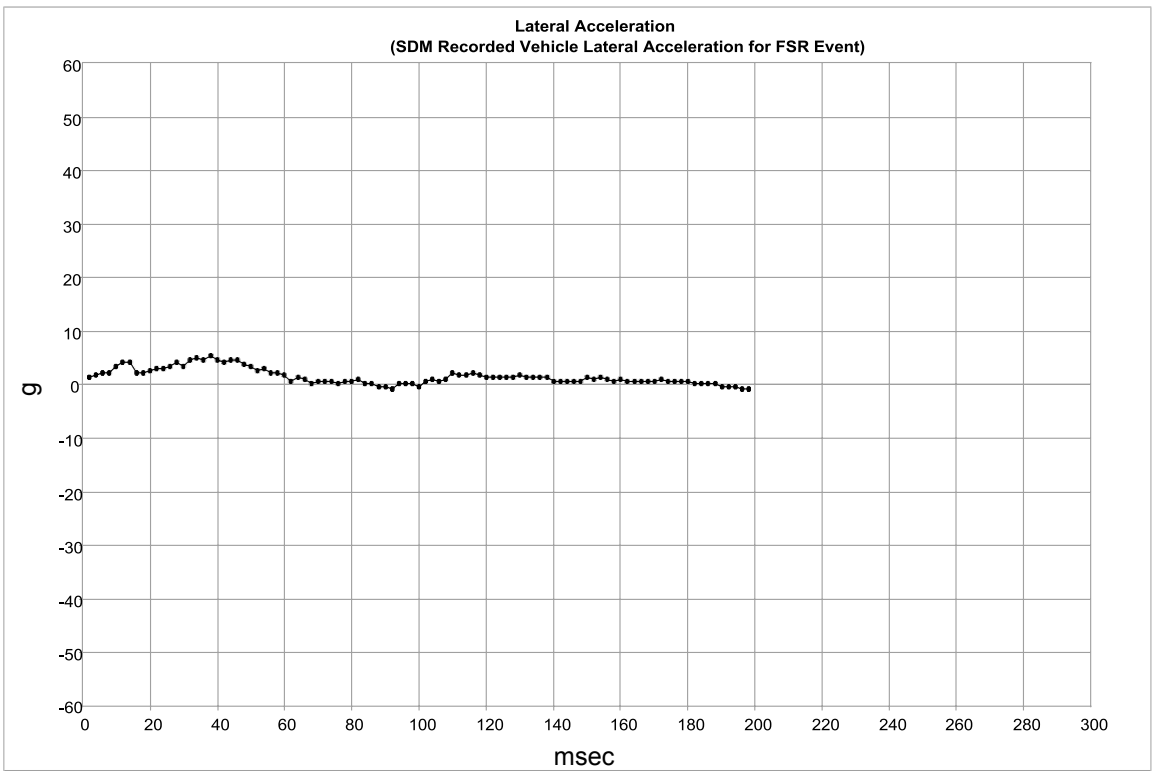
Time (msec)	Delta-V, Longitudinal (SDM Recorded Vehicle Longitudinal Velocity Change for FSR Event) (MPH)	Delta-V, Longitudinal (SDM Recorded Vehicle Longitudinal Velocity Change for FSR Event) (km/h)
10	0.0	0.0
20	0.0	0.0
30	0.0	0.0
40	0.6	1.0
50	1.2	2.0
60	1.2	2.0
70	0.6	1.0
80	1.2	2.0
90	1.2	2.0
100	1.9	3.0
110	1.9	3.0
120	1.9	3.0
130	1.9	3.0
140	2.5	4.0
150	2.5	4.0
160	2.5	4.0
170	2.5	4.0
180	2.5	4.0
190	2.5	4.0
200	2.5	4.0
210	2.5	4.0
220	2.5	4.0
230	2.5	4.0
240	2.5	4.0
250	2.5	4.0
260	2.5	4.0
270	2.5	4.0
280	2.5	4.0
290	2.5	4.0
300	2.5	4.0

Longitudinal Crash Pulse (Event Record 3)

Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event) (g)	Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event) (g)	Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event) (g)
2	-0.2	102	0.6	202	Data Not Available
4	-0.2	104	0.6	204	Data Not Available
6	-0.2	106	0.6	206	Data Not Available
8	-0.2	108	1.0	208	Data Not Available
10	0.2	110	1.4	210	Data Not Available
12	0.2	112	0.6	212	Data Not Available
14	0.2	114	0.6	214	Data Not Available
16	-0.6	116	0.6	216	Data Not Available
18	-1.0	118	0.2	218	Data Not Available
20	0.2	120	0.2	220	Data Not Available
22	-0.2	122	0.2	222	Data Not Available
24	0.6	124	0.2	224	Data Not Available
26	-0.2	126	0.2	226	Data Not Available
28	0.6	128	0.2	228	Data Not Available
30	0.2	130	0.2	230	Data Not Available
32	1.4	132	0.2	232	Data Not Available
34	1.4	134	0.2	234	Data Not Available
36	1.8	136	0.6	236	Data Not Available
38	2.6	138	0.6	238	Data Not Available
40	2.2	140	0.2	240	Data Not Available
42	1.8	142	0.6	242	Data Not Available
44	1.4	144	0.2	244	Data Not Available
46	1.8	146	0.2	246	Data Not Available
48	2.2	148	0.2	248	Data Not Available
50	1.4	150	0.2	250	Data Not Available
52	1.8	152	0.2	252	Data Not Available
54	0.6	154	0.6	254	Data Not Available
56	-0.6	156	0.6	256	Data Not Available
58	-1.0	158	0.2	258	Data Not Available
60	-0.6	160	0.2	260	Data Not Available
62	-1.0	162	0.2	262	Data Not Available
64	-0.6	164	0.6	264	Data Not Available
66	-1.0	166	0.2	266	Data Not Available
68	-0.6	168	0.2	268	Data Not Available
70	-0.2	170	0.2	270	Data Not Available
72	0.2	172	0.2	272	Data Not Available
74	0.6	174	0.2	274	Data Not Available
76	0.6	176	0.2	276	Data Not Available
78	0.6	178	0.2	278	Data Not Available
80	0.6	180	0.2	280	Data Not Available
82	1.0	182	0.2	282	Data Not Available
84	1.0	184	0.2	284	Data Not Available
86	1.0	186	0.2	286	Data Not Available
88	0.6	188	0.2	288	Data Not Available
90	2.2	190	0.2	290	Data Not Available
92	1.0	192	0.2	292	Data Not Available
94	0.6	194	0.2	294	Data Not Available
96	0.6	196	0.6	296	Data Not Available
98	1.4	198	0.2	298	Data Not Available
100	0.2	200	Data Not Available	300	Data Not Available

Lateral Crash Pulse (Event Record 3)





Lateral Crash Pulse (Event Record 3)

Time (msec)	Delta-V, Lateral (SDM Recorded Vehicle Lateral Velocity Change for FSR Event) (MPH)	Delta-V, Lateral (SDM Recorded Vehicle Lateral Velocity Change for FSR Event) (km/h)
10	0.6	1.0
20	1.2	2.0
30	2.5	4.0
40	3.1	5.0
50	4.3	7.0
60	5.0	8.0
70	5.0	8.0
80	5.0	8.0
90	5.0	8.0
100	5.0	8.0
110	5.6	9.0
120	6.2	10.0
130	6.2	10.0
140	6.8	11.0
150	6.8	11.0
160	7.5	12.0
170	7.5	12.0
180	7.5	12.0
190	7.5	12.0
200	7.5	12.0
210	7.5	12.0
220	7.5	12.0
230	7.5	12.0
240	7.5	12.0
250	7.5	12.0
260	7.5	12.0
270	7.5	12.0
280	7.5	12.0
290	7.5	12.0
300	7.5	12.0

Lateral Crash Pulse (Event Record 3)

Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)	Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)	Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)
2	1.4	102	0.6	202	Data Not Available
4	1.8	104	1.0	204	Data Not Available
6	2.2	106	0.6	206	Data Not Available
8	2.2	108	1.0	208	Data Not Available
10	3.4	110	2.2	210	Data Not Available
12	4.2	112	1.8	212	Data Not Available
14	4.2	114	1.8	214	Data Not Available
16	2.2	116	2.2	216	Data Not Available
18	2.2	118	1.8	218	Data Not Available
20	2.6	120	1.4	220	Data Not Available
22	3.0	122	1.4	222	Data Not Available
24	3.0	124	1.4	224	Data Not Available
26	3.4	126	1.4	226	Data Not Available
28	4.2	128	1.4	228	Data Not Available
30	3.4	130	1.8	230	Data Not Available
32	4.6	132	1.4	232	Data Not Available
34	5.0	134	1.4	234	Data Not Available
36	4.6	136	1.4	236	Data Not Available
38	5.4	138	1.4	238	Data Not Available
40	4.6	140	0.6	240	Data Not Available
42	4.2	142	0.6	242	Data Not Available
44	4.6	144	0.6	244	Data Not Available
46	4.6	146	0.6	246	Data Not Available
48	3.8	148	0.6	248	Data Not Available
50	3.4	150	1.4	250	Data Not Available
52	2.6	152	1.0	252	Data Not Available
54	3.0	154	1.4	254	Data Not Available
56	2.2	156	1.0	256	Data Not Available
58	2.2	158	0.6	258	Data Not Available
60	1.8	160	1.0	260	Data Not Available
62	0.6	162	0.6	262	Data Not Available
64	1.4	164	0.6	264	Data Not Available
66	1.0	166	0.6	266	Data Not Available
68	0.2	168	0.6	268	Data Not Available
70	0.6	170	0.6	270	Data Not Available
72	0.6	172	1.0	272	Data Not Available
74	0.6	174	0.6	274	Data Not Available
76	0.2	176	0.6	276	Data Not Available
78	0.6	178	0.6	278	Data Not Available
80	0.6	180	0.6	280	Data Not Available
82	1.0	182	0.2	282	Data Not Available
84	0.2	184	0.2	284	Data Not Available
86	0.2	186	0.2	286	Data Not Available
88	-0.2	188	0.2	288	Data Not Available
90	-0.2	190	-0.2	290	Data Not Available
92	-0.6	192	-0.2	292	Data Not Available
94	0.2	194	-0.2	294	Data Not Available
96	0.2	196	-0.6	296	Data Not Available
98	0.2	198	-0.6	298	Data Not Available
100	-0.2	200	Data Not Available	300	Data Not Available

Rollover Crash Pulse (Event Record 3)
SDM Recorded Vehicle Roll Rate

Contains No Recorded Data

Rollover Crash Pulse (Event Record 3)
Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for Rollover Event)

Contains No Recorded Data

Vertical Crash Pulse (Event Record 3)
Normal Acceleration (SDM Recorded Vehicle Vertical Acceleration for Rollover Event)

Contains No Recorded Data

Pre-Crash Data -5.0 to -0.5 sec (Event Record 3)

Times (sec)	Accelerator Pedal, % Full (Accelerator Pedal Position)	Service Brake (Brake Switch Circuit State)	Engine RPM (Engine Speed)	Engine Throttle, % Full (Throttle Position)	Speed, Vehicle Indicated (Vehicle Speed) (MPH [km/h])
-5.0	0	On	2240	19	66 [106]
-4.5	99	On	1664	22	58 [93]
-4.0	44	On	2432	93	55 [89]
-3.5	99	On	3712	99	58 [94]
-3.0	0	On	4480	40	63 [102]
-2.5	Data Not Available	On	Data Not Available	Data Not Available	Data Not Available
-2.0	Data Not Available	On	Data Not Available	Data Not Available	Data Not Available
-1.5	Data Not Available	On	Data Not Available	Data Not Available	Data Not Available
-1.0	Data Not Available	On	Data Not Available	Data Not Available	Data Not Available
-0.5	Data Not Available	On	Data Not Available	Data Not Available	Data Not Available

Pre-Crash Data -2.0 to -0.5 sec (Event Record 3)

Times (sec)	Cruise Control Active	Cruise Control Resume Switch Active	Cruise Control Set Switch Active	Engine Torque (lb-ft [N-m])	Reduced Engine Power Mode Indicator
-2.0	No	No	No	Data Not Available	Off
-1.5	No	No	No	Data Not Available	Off
-1.0	No	No	No	Data Not Available	Off
-0.5	No	No	No	Data Not Available	Off

Hexadecimal Data

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 0810   FF FF FF FF FF FF FF FF FF FF
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 1110   FF 01 03 5C F9 16 80 00 01 00
 1120   FF FF 06 09 20 05 11 2B 05 FF
 1130   FF FF FF FF FF FF FF FF FF FF
 1140   FF FF FF FF FF FF FF FF FF FF
 1150   FF 00 00 04 32 00 00 00 28 00
 1160   00 4C E0 D8 01 00 00 13 0F 2A
 1170   2B FF FF 00 00 00 00 01 FF FF
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 1190   FF FF FF FF FF FF FF FF FF FF
 1200   FF

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 0010   4F 00 FF FF 10 00 20 00 00 00
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 0030   FF FF FF 00 63 2C 63 00 55 55
 0040   50 00 00 00 00 FF FF FF FF FF
 0050   46 3A 26 1A 23 0F FF 0F FF 0F
 0060   FF 0F FF FF FF FF FF FF 28 63
 0070   5D 16 13 FF FF FF FF FF 66 5E
 0080   59 5D 6A 10 00 00 00 00 FD 80
 0090   52 00 FF FF FF FF FF FF FF FF
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 0120   FF FF FF FF 0B FF FF FF 7F 80
 0130   7F 81 7F 83 80 84 81 86 81 87
 0140   80 87 81 87 81 87 82 87 82 88
 0150   82 89 82 89 83 8A 83 8A 83 8B
 0160   83 8B 83 8B 83 8B 83 8B 83 8B
 0170   83 8B 83 8B 83 8B 83 8B 83 8B
 0180   83 8B 83 8B 83 8B 83 8B 7F 83
 0190   7F 84 7F 85 7F 85 80 88 80 8A
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0200    80 8A 7E 85 7D 85 80 86 7F 87
0210    81 87 7F 88 81 8A 80 88 83 8B
0220    83 8C 84 8B 86 8D 85 8B 84 8A
0230    83 8B 84 8B 85 89 83 88 84 86
0240    81 87 7E 85 7D 85 7E 84 7D 81
0250    7E 83 7D 82 7E 80 7F 81 80 81
0260    81 81 81 80 81 81 81 81 82 82
0270    82 80 82 80 81 7F 85 7F 82 7E
0280    81 80 81 80 83 80 80 7F 81 81
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0690    FF FF FF FF FF FF FF FF FF FF
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0920    FF FF FF 10 00 00 00 00 20 38
0930    00 00 00 00 00 00 00 00 00 00
0940    00 00 00 00 00 12 C2 05 00 00
0950    03 00 00 00 20 38 21 02 20 4A
0960    21 70 FF FF FF FF FF FF FF FF
0970    FF FF FF FF FF FF FF FF FF FF
0980    FF 08 00 40 20 14 00 44 00 00
0990    00 20 02 21 8C FF FF FF FF FF
1000    FF FF FF FF FF FF FF FF FF FF
1010    FF FF FF FF FF FF 00 04 00 00
1020    00 20 40 21 8C FF FF FF FF FF
1030    FF FF FF FF FF FF FF FF FF FF
1040    FF 00 00 03 00 00 03 00 00 00
1050    00 00 00 00 00 00 00 20 02 00
1060    00 00 20 40 00 00 00 00 00 00
1070    00 00 00 00 00 00 00 20 09 00
1080    00 00 00 00 00 00 00 00 00 00
1090    00 00 00 00 00 00 00 FF FF FF
1100    FF FF FF FF FF FF FF FF FF FF
1110    FF FF FF FF FF FF FF FF FF FF
1120    FF FF FF FF FF FF FF FF FF FF
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1140    FF FF FF FF FF FF FF FF FF FF
1150    FF 00 00 04 32 00 00 0D 18 00
1160    00 4C F0 B2 00 00 00 1B DF 00
1170    C5 FF FF 00 00 00 00 01 FF FF
1180    FF FF FF FF FF FF FF FF FF FF
1190    FF FF FF FF FF FF FF FF FF FF
1200    FF
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September 2018

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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