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**Special Crash Investigations:
On-Site Seat Belt Separation Crash
Investigation;
Vehicle: 2011 GMC Terrain;
Location: Florida;
Crash Date: June 2020**

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16. Abstract This report documents the offset frontal crash of a 2011 GMC Terrain SUV and the shear/separation of the driver's seat belt webbing at the belt path of the latch plate. The GMC was involved in a head-on crash with a 2011 Subaru Forrester. A belted 41-year-old male drove the GMC at the time of the crash, which occurred when the Subaru, driven by a belted 39-year-old female and occupied by a belted 9-year-old female second-row right passenger, crossed over the centerline of a two-lane roadway. The front of the GMC struck the front of the Subaru. The GMC rotated counterclockwise, and the Subaru rotated clockwise, with both vehicles coming to final rest blocking the roadway. As the GMC driver loaded the seat belt during the crash, the webbing separated. The separation was located 53 cm (20.75 in) above the webbing's attachment to the lower anchor pretensioner. The driver sustained police-reported B-level (non-incapacitating) injuries. He was transported by ambulance and hospitalized for 17 days. The 9-year-old child was deceased. At the conclusion of the inspection, the driver's seat belt and associated components were removed from the vehicle and forwarded to NHTSA's Vehicle Research and Test Center for examination. Inspection of the parts suggested that the belt webbing separated due to excessive loading.			
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Special Crash Investigations
On-Site Seat Belt Separation Crash Investigation
Office of Defects Investigation
Case Number: CR20025
Vehicle: 2011 GMC Terrain
Location: Florida
Crash Date: June 2020

Background

This report documents the offset frontal crash of a 2011 GMC Terrain SUV and the shear/separation of the driver's seat belt webbing at the belt path of the latch plate (Figure 1). The GMC was involved in a head-on crash with a 2011 Subaru Forrester. A belted 41-year-old male drove the GMC at the time of the crash, which occurred when the Subaru, driven by a belted 39-year-old female and occupied by a belted 9-year-old female second-row right passenger, crossed over the centerline of a two-lane roadway. The front of the GMC struck the front of the Subaru head-on. The GMC rotated counterclockwise and the Subaru rotated clockwise, with both vehicles coming to final rest blocking the roadway. The driver of the GMC and the driver of the Subaru both sustained police-reported non-incapacitating (B-level) injuries in the crash and were transported to a local hospital for treatment. The 9-year-old female second-row occupant of the Subaru was also transported by ambulance to a local hospital, where she was pronounced deceased.



Figure 1. View of the buckled latch plate and portion of the separated webbing of the GMC driver's seat belt system (image provided to NHTSA by the investigating law enforcement agency)

This crash was identified by the National Highway Traffic Safety Administration from news articles regarding vehicles of interest, and further research was requested through NHTSA's Crash Investigation Division due to the seat belt separation. The crash was then assigned for on-site investigation to the SCI team at Crash Research & Analysis in August 2020. The SCI team contacted the law enforcement investigator and established cooperation to inspect the GMC, which was in the law enforcement agency's possession. The on-site investigation took place in August 2020.

The on-site activities included inspection of the GMC to measure its exterior deformation, interior damage, and intrusion, to document any evidence of interior occupant contact, and to examine the manual and supplemental restraint systems. Additional investigation concerned the circumstances surrounding the driver's seat belt separation in the GMC. Components of the seat belt system were removed from the vehicle and forwarded to NHTSA's Vehicle Research and Test Center for further examination. The GMC had an Event Data Recorder (EDR) that was imaged during the inspection process using the Bosch Crash Data Retrieval (CDR) tool and software. The crash site was photographed and measured by a total station mapping system. The driver of the GMC was contacted by telephone and interviewed. The Subaru was not available for inspection.

Summary

Crash Site

The crash occurred on a two-lane road in the afternoon. At the time of the crash, the National Weather Service reported the conditions as partly cloudy with a temperature of 30°C (86°F), a relative humidity of 70 percent, with winds of 11 km/h (7.0 mph) from the south-southeast. The police reported the conditions as clear and dry. The roadway consisted of one 3.3 m (10.8 ft) lane in each of the north and southbound travel directions. The northbound lane was bordered by a marked bicycle lane. A paved shoulder was located beyond the bicycle lane at the east roadside for northbound traffic. In the vicinity of the crash site, the roadway was straight and level with all surfaces paved with bituminous concrete. The west roadside adjacent to the southbound travel lane was surfaced with grass and was relatively level. The east shoulder was bordered by a concrete curb, a W-beam guardrail system, and a concrete sidewalk. The posted speed limit was 72 km/h (45 mph). Figures 2 and 3 are overall views of the crash site in the southbound direction of the GMC and northbound direction of the Subaru.



Figure 2. Southbound trajectory view of the GMC approaching the impact site

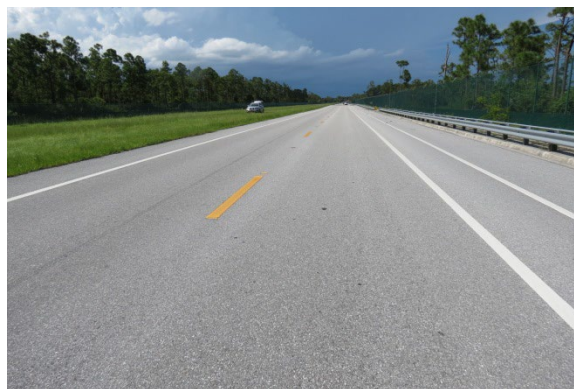


Figure 3. Northbound trajectory view of the Subaru as it crossed into the opposing lane

Pre-Crash

The driver of the 2011 GMC drove to a retail establishment to pick up an office chair for his wife that he placed in the cargo area of the vehicle. On the return trip to his residence, he was

traveling south on the two-lane road (Figure 2). The driver stated during the SCI interview that he was talking to his wife on Bluetooth. The 2011 Subaru was traveling north (Figure 3), and for reasons unknown, the driver allowed the vehicle to cross the centerline of the roadway into the southbound travel lane. The GMC driver stated to his wife on the cell phone, “What are they doing?” He stated that he initially steered right and then left as he applied the brakes in an attempt to avoid the crash. The SCI crash reconstruction determined that the Subaru driver initiated a right steering maneuver immediately prior to impact in an attempt to regain the northbound travel lane. The GMC’s EDR recorded a travel speed of 87 km/h (54 mph) at -2.5 seconds of algorithm enable (AE). It also recorded that the driver had applied the brakes at the time and continued brake pedal application until -0.5 second of AE. The GMC’s speed was reduced to 57 km/h (35 mph) at -0.5-second interval. The accelerator pedal position (percentage) was zero for the entire pre-crash data capture.

The police investigation documented the GMC’s front tire brake marks that originated in the southbound travel lane and arced toward the centerline of the roadway, indicative of a probable left steering maneuver at or during the brake initiation. The on-scene tire marks were faint due to activation of the GMC’s ABS system. The left front tire mark was 14.6 m (47.9 ft) long and the right front tire mark was 14.3 m (46.9 ft) long, both terminating at the point of impact. These tire marks had eroded from the road surface and were not visible during the SCI investigation, which occurred six weeks after the crash.

Crash

The vehicles collided in a near-full overlap head-on configuration in the center of the roadway. Several gouge marks showed the impact location that were located 0.9 m (3.0 ft) forward of the end of the GMC’s right front tire mark. The resultant directions of force were within the 11 o’clock sector for the GMC and 1 o’clock for the Subaru. The EDR recorded a longitudinal velocity change of -56 km/h (-35 mph) for the GMC, with a lateral component of -20 km/h (-12 mph). The “missing vehicle” algorithm of the WinSMASH program calculated the GMC’s total delta V as 35 km/h (22 mph). The longitudinal and lateral velocity changes were -33 km/h (-21 mph) and -12 km/h (-8 mph). The results were considered borderline and low for the severity of damage to the GMC.

The impact actuated the seat belt pretensioners in the GMC 3 msec after AE and deployed the driver’s frontal air bag and the inflatable curtain (IC) air bags. The driver’s frontal air bag was a stage-two deployment, with stage one commanded at 6 msec of AE and stage two at 9 msec. The IC air bags deployed at 108 msec of AE.

The lateral components of the force vectors rotated the GMC counterclockwise and deflected the Subaru clockwise as the vehicles were displaced to final rest. Based on the physical evidence documented by the police and final rest positions of the vehicles, the GMC’s center of gravity (CG) was displaced 3 m (9.8 ft) in a west-southwest direction with the vehicle rotating 30 degrees counterclockwise. At final rest, the GMC was diagonal to the northbound travel lane, with its front plane positioned in the east shoulder (Figure 4). The Subaru was displaced laterally to the east with its CG redirected roughly 1.5 m (5 ft) to the east (Figure 5). At final rest, the Subaru rotated roughly 65 degrees clockwise, facing in an easterly direction. Its CG was near the centerline of the roadway as it blocked both travel lanes.



*Figure 4. Southerly view of the vehicles at final rest
(law enforcement image)*



*Figure 5. Northerly view of the vehicles at final rest
(law enforcement image)*

Post-Crash

The GMC driver sustained incapacitating injuries and remained in the vehicle post-crash. Firefighters used emergency equipment to cut the left B-pillar from the GMC and removed the left rear door to aid in the extrication of the driver. Additionally, the driver's seatback was reclined to facilitate his removal. He was placed on a backboard and transferred to an ambulance, then transported to a level 1 trauma center, where he was admitted for 17 days for treatment and recovery of his injuries.

The 39-year-old female driver was assisted from the Subaru and transported to the trauma center, with police-reported non-incapacitating injuries. The severity of her injuries and the level of her treatment are unknown. The 9-year-old female second-row right passenger of the Subaru was belted; however, on-scene police images of the vehicle indicated that she loaded the seat belt webbing and the seatback of the right front seat with sufficient force to deform the seatback. She was removed from the vehicle by first responders and transported to the trauma center, where she expired within five days of the crash. The Subaru was in the possession of an attorney representing its driver and was not inspected for this SCI investigation.

2011 GMC Terrain

Description

The involved vehicle was a 2011 GMC Terrain (Figure 6) equipped with the SLT 2 trim package. It was manufactured in April 2011 and was identified by the Vehicle Identification Number 2CTFLWE50B6xxxxxx. The power train consisted of a 3.0-liter, gasoline engine linked to a 6-speed automatic transmission with a console-mounted transmission selector lever and front-wheel drive. The service brakes were power-assisted hydraulic disc with ventilated rotors front and rear. ABS was standard and so were traction control, electronic stability control, electronic brakeforce distribution emergency brake assist, and a direct tire pressure monitoring system. The steering was electric rack-and-pinion with speed-proportional assist. The vehicle placard listed the gross vehicle weight rating at 2,360 kg (5,202 lb), with specific gross axle weight ratings of 1,250 kg (2,755 lb) in front and 1,240 kg (2,733 lb) in rear. The GMC had Sailun Terramax HLT all-season tires of the vehicle manufacturer's recommended size of P235/55R18 mounted on 6-spoke OEM alloy wheels. The vehicle manufacturer's recommended cold tire pressure was 240 kPa (35 PSI). All the tire treads measured 9 mm (11/32).



Figure 6. Right front oblique view of the GMC

The interior of the GMC had seating for five occupants (2/3) with front-row bucket seats and a 3-passenger second-row bench seat with forward-folding seatbacks. The driver's seat was 8-way power adjustable, while the front right seat was 4-way manually adjustable. All seating surfaces were leather. Both rows had adjustable head restraints. The driver's head restraint was adjusted 6 cm (2.4 in) above the seatback. The steering column was configured with tilt and telescoping features. Safety systems consisted of manual 3-point lap and shoulder seat belts for the five seat positions with front-row supplemental certified advanced 208-compliant (CAC) frontal air bags, side impact sensing front seat-mounted air bags, and roof side rail-mounted IC air bags that provided protection to both seat rows. The front-row seat belts had lower anchor and retractor pretensioners. The window glazing was AS1 for the laminated windshield, AS2 for the front door windows, and AS3 deep tint for the rear door, rear quarter windows, backlight, and sunroof glazing.

Vehicle History

The GMC had a history of three owners as noted in a Carfax report obtained for this investigation. The original owner leased the vehicle in April 2011 and turned the vehicle in to the

dealer network in April 2014. Reported service during this lease period consisted of routine maintenance and no reported crashes.

The second owner purchased the GMC in April 2014 at a reported odometer reading of 59,922 km (37,235 mi). During this ownership period, the reported service history consisted of routine maintenance. There was a reported crash that resulted in back plane damage in May 2014. No air bag deployment was reported, and the vehicle was listed as functional. The GMC was repaired and returned to service. This owner sold the vehicle in February/March 2015.

The third, current owner at the time of this crash purchased the GMC in March 2015. The odometer reading was not reported. Service history was reported as routine maintenance, with an ABS sensor replaced in April 2020 at a reported odometer reading of 192,575 km (119,664 mi). This crash was recorded in June 2020 at an unknown odometer reading. The Carfax damage severity scale was reported as moderate-to-severe.

NHTSA Recalls and Investigations

A VIN-based query of NHTSA's recall database www.nhtsa.gov/recalls in August 2020 and one at the time of this report submission showed no open or unrepaired recalls for this specific GMC Terrain. A query by year/make/model reported two NHTSA investigations of the 2011 GMC Terrain. These pertained to the windshield wiper transmission EA19005 and a potential power steering issue PE20009.

Exterior Damage

The GMC sustained severe frontal damage from its impact sequence with the Subaru. The direct contact damage began 26 cm (10.2 in) left of the vehicle's centerline and extended 112 cm (44.1 in) along the front plane to the right corner. The offset-right engagement produced an angular damage pattern to the front plane (Figure 7) of the GMC, resulting in a combined induced and direct damage length of 97 cm (38.2 in), measured across the front reference line. Maximum crush was 56 cm (22.0 in) located 35 cm (13.8 in) right of the centerline (Figure 8). Components damaged by the crash involved the front bumper fascia, bumper beam, the right frame rail, grille, headlamp assemblies, hood, right front fender, windshield, leading edge of the right front door, AC condenser, radiator, radiator support, and rearward displacement of the drivetrain. The right wheelbase was reduced in length by 28 cm (11.0 in). Due to wheelbase reduction, the right front tire was compressed against the aft aspect of the wheel opening and was aired out and restricted. A crush profile was documented at the level of the bumper beam and was as follows: C1 = 0 cm, C2 = 11 cm (4.3 in), C3 = 29 cm (11.4 in), C4 = 40 cm (15.7 in), C5 = 46 cm (18.1 in), and C6 = 56 cm (22.0 in). The collision deformation classification for this damage was 01FZEW3.



Figure 7. Frontal damage to the GMC



Figure 8. Right lateral view documenting the extent of crush to the GMC

Event Data Recorder

The GMC was equipped with an air bag control module (ACM) that had EDR capabilities to record deployment and non-deployment events. The module had the capacity to store three events. Deployment events could not be overwritten or cleared by the EDR. Non-deployment events could 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. A non-deployment event could also be recorded without an air bag deployment if one of the following occurs: pretensioner-only deployment, head restraint deployment, or battery cut-off deployment. The GMC's EDR was imaged during the police investigation with version 19.4 of the Bosch Crash Data Retrieval software. This electronic file was forwarded to NHTSA by the investigating officer. The imaged file, reported with version 21.3 of the CDR software, is attached to this report as Appendix A.

The imaged data reported three records: a non-deployment, deployment, and another non-deployment event. The first non-deployment occurred 8,287 ignition cycles prior to the crash under investigation and therefore was unrelated to this crash. The deployment and non-deployment events related to this crash were both completely recorded. The driver's seat belt switch circuit status was reported as "Buckled" for both events, and the time between events was reported as 0.56 sec.

Event Data, Deployment Event

The deployment event was recorded during the GMC's impact with the Subaru. The SIR warning lamp status was "Off" prior to the crash. After the crash, one diagnostic trouble code (DTC) was reported, B0052-00. This code indicated that the vehicle was involved in a deployment event and that the data were stored in the ACM. The record indicated that the longitudinal and lateral velocity changes were -56 km/h (-35 mph) and -20 km/h (-12 mph), respectively, and that the time from AE to maximum delta V was 90 msec. Deployment command criteria were met for both pretensioners at 3 msec after AE, the first and second stage deployments of the driver's frontal air bag at 6 msec and 9 msec and IC air bags at 108 msec.

Event Data, Non-Deployment Event

This event was recorded 0.56 sec after the GMC's impact with the Subaru. The record indicated that the maximum longitudinal and lateral velocity changes were 3 km/h (2 mph) and 12 km/h (7 mph), respectively. It is likely that this non-deployment event was recorded during a secondary contact between the vehicles during the rotation as they slid to final rest.

Interior Damage

The interior damage of the GMC was primarily related to intrusion, air bag deployment, and driver contact. The frontal impact resulted in an isolated 4 cm (1.6 in) of intrusion of the right toe pan. There was no measurable intrusion into the driver's compartment. The driver's frontal air bag deployed through the I-configuration cover flaps of the driver's air bag module, contained in the steering wheel hub and spokes. Both IC air bags deployed from the roof side rails. The driver's frontal air bag was scuffed at the 6 o'clock sector; however, this scuffing was related to expansion in the module covers during the initial deployment. There was no distinct occupant contact or damage to the deployed air bags.

The driver initially loaded the seat belt system as evidenced by striations on the lap belt webbing and complete separation of the webbing at the location of the latch plate. The remaining shoulder belt webbing retracted onto the retractor post-crash, but the retractor was damaged during extrication of the driver; consequently, the belt webbing could not be extended from the retractor.

During the impact, the driver translated forward and loaded the deployed frontal air bag. His loading force was transmitted through the air bag and into the steering assembly. There was no deformation of the steering wheel rim; however, his loading force deformed the steering wheel mounting flange evidenced by a closure of the gap between the wheel and the column jacket at the 6 o'clock sector (Figure 9) and compressed the energy absorbing steering column, while displacing the column vertically upward.

The driver's knees contacted, scuffed, and deformed the knee bolster and the bottom of the steering column cover. His left knee deformed the steel backer plate (Figure 10), left of the steering column.



Figure 9. Bending of the steering wheel flange from driver loading



Figure 10. Driver knee contact evidence and damage to the lower steering column cover and knee bolster backer panel

Manual Restraint Systems

The GMC had manual 3-point lap and shoulder seat belts for the five designated seat positions. All seat belt systems used continuous loop webbing. The front-row seat belts were configured with lightweight locking latch plates and adjustable D-rings. Both D-rings were adjusted to the full-up positions. The front-row seat belt systems were equipped with retractor and lower anchor pretensioners that actuated early in the crash event, 3 msec after AE. The driver's seat belt webbing retracted onto an emergency locking retractor. All other seat belts used a switchable automatic locking/emergency locking retractor.

At the inspection, the separated driver's seat belt webbing was lying on the driver seat. This webbing section measured 53 cm (20.75 in) long and was attached to the actuated lower anchor pretensioner (Figure 11). The webbing revealed indicators of occupant loading, with cupping and linear-oriented stress marks along the length of the webbing. The separated end of the webbing had a shallow angle across its width. The latch plate was still in the buckle and latched with correct orientation. Examination revealed evidence of historical use (Figure 12). The cinching bar was polished due to its interaction with the seat belt, with areas of light rust. It moved freely in the slots of the plate. The opposing rubber surface appeared abraded. The exterior trim cover for the latch plate had separated and was lying on the seat cushion.

The left B-pillar had been removed during the extrication of the driver, and during its removal the driver's seat belt retractor at the base of the pillar was damaged (Figure 13). The separated webbing had spooled back into the retractor and could not be extended. The ending of this webbing matched the separated section attached to the lower anchor pretensioner.



Figure 11. Post-crash status of driver's seat lower anchor pretensioner, lap webbing fractured



Figure 12. Close-up view of the GMC driver's lightweight locking latch plate



Figure 13. Close-up view of the driver's retractor removed from the GMC

Driver Seat Belt Discussion

The seat belt components were removed from the vehicle and shipped to NHTSA's Vehicle Research and Test Center for further inspection. That process and examination are summarized as follows:

- The anchor pretensioner activated and appears to have operated as designed.
- The retractor bracket was severely bent which would be expected in a high-energy event.
- The buckle stalk appeared undamaged and in working order.
- The buckle tongue did not appear mechanically damaged. Plastic parts of the tongue were broken and missing. The sliding pin portion of the tongue (transition point lap belt to shoulder belt) displayed mild corrosion and rust. The edge of the pin, interaction point with the belt, was shiny/polished.
- The seat belt webbing was separated at the tongue. The webbing displayed signs of puckering and uneven separation of filaments indicating high stress.
- The belt webbing and tongue were examined at various magnifications using a Leica DVM 2500 digital microscope.
- Microscopic imaging: Magnified images of the filament ends of the belt were taken. Examination of the filament ends at the area of separation indicate probable overstress (tensile) fracture failure mode. The images represent a sampling of the filament ends examined in the separation area. Many of the filament ends reveal minor mushrooming, typically formed during a high-speed tensile fracture. The globular appearance of some filaments suggests melting of the material, which is also indicative of high-speed tensile fracture (Figure 14).



*Figure 14. Tensile fracture of the lap belt webbing.
Image taken during VRTC inspection*

The SCI investigation determined that the driver's seat belt separation occurred due to occupant loading during the impact. The maximum longitudinal velocity change recorded by the EDR was -56 km/h (-35 mph). Several undetermined factors may have contributed to the separation and remain unknown. These factors include seat belt geometry and placement, pre-crash condition of the webbing, as well as the potential presence of stress concentrations in the area of separation and degradation of webbing due to age, heat, and exposure to the elements.

Supplemental Restraint Systems

The GMC had a CAC frontal air bag system and front-seat-mounted side impact and roof side rail-mounted IC air bags. The CAC system consisted of dual-stage driver's and passenger's frontal air bags, seat track positioning sensors, seat belt buckle switches, a front right occupant classification sensor, front right air bag suppression, and retractor and lower anchor pretensioners. This crash resulted in the actuation of the seat belt pretensioners (3 msec), the deployment of the driver's frontal air bag (stage 1 at 6 msec and stage 2 at 9 msec), and the deployment of both IC air bags (108 msec).

The driver's frontal air bag deployed through an I-configuration module cover from the center hub of the steering wheel (Figure 15). The module cover flaps were 13 cm (5.1 in) in overall width and 12 cm (4.7 in) in overall height. A scuffmark was present at the lower left corner of the cover flap that probably resulted from deployment. The air bag was tethered and had an overall diameter of 58 cm (22.8 in) as measured in its deflated state. The air bag was directly vented to the occupant compartment by two ports located on the bag side of the air bag at the 10 and 2 o'clock positions. Vertically oriented scuffing was noted to the lower aspect of the air bag that appeared to be related to air bag expansion during the deployment sequence. There was no residual evidence of occupant contact or damage to the air bag.



Figure 15. Deployed GMC driver's frontal air bag

The roof side-rail mounted IC air bags (Figure 16) deployed through the separation of the roof headliner from the side rail. The IC air bags were 206 cm (81.1) in overall length inclusive of a sail panel to fill the triangular void of the A-pillar and were 49 cm (19.3 in) in vertical height. The IC air bags provided a full coverage of the side glazing areas extending from the A-pillar to the D-pillar and below the level of the beltline. There was no driver contact evidence on the left IC air bag. A hole was documented to the left IC air bag that resulted from the post-crash

extrication efforts. The 8 x 6 cm (20.3 x 15.2 in) hole was located 83 cm (32.7 in) forward of the C-pillar and 95 cm (37.4 in) above the floor.



Figure 16. Deployed GMC left IC air bag

2011 GMC Terrain Occupant

Driver Demographics

Age/sex: 41 years/male
 Height: 193 cm (76 in)
 Weight: 108 kg (238 lb)
 Eyewear: Unknown
 Seat type: Bucket seat with adjustable head restraint
 Seat track position: Rear track
 Manual restraint usage: 3-point lap and shoulder belt
 Usage source: Vehicle inspection, EDR
 Air bags: Front, seat-mounted, and IC air bags; front and IC bags deployed
 Alcohol/drug data: Test not given
 Egress from vehicle: Removed by EMS
 Transport from scene: Transported to a level 1 medical center; admitted for 17 days

Driver Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
1	Small bowel transection	541426.4	Isolated IPC Interior – Lap portion of belt restraint	Probable
2	Mesenteric injury with multiple defects; tear screening windows devitalization of bowel	542026.4	Isolated IPC Interior – Lap portion of belt restraint	Probable
3	Two to three areas of ileal perforation	541423.3	Isolated IPC Interior – Lap portion of belt restraint	Probable
4	Large subcapsular splenic collection suggesting a subcapsular hematoma from splenic injury measuring 17.5 x 11.5 x 8 cm	544214.3	Isolated IPC Interior – Lap portion of belt restraint	Probable
5	Laceration of distal sigmoid colon	540820.2	Isolated IPC Interior – Lap portion of belt restraint Lap belt	Probable
6	Lung contusion, right lower lobe	441406.2	Tandem IPC Primary: Interior – Shoulder portion of belt restraint Secondary: Left Air Bag – Steering wheel hub Tertiary: Front – Steering wheel (combination of rim and hub/spoke)	Probable Possible Possible

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Components (IPC)	IPC Confidence Level
7	Bilateral comminuted nasal bone fracture, depressed	251002.2	Tandem IPC Primary: Left Air Bag – Steering wheel hub Secondary: Front – Steering wheel rim	Possible Probable
8	Multiple teeth broken, NFS	251404.1	Isolated Front – Steering wheel rim	Probable
9	Abrasion to anterior right forearm	710202.1	Isolated Left Air Bag – Steering wheel hub	Certain
10	Skin tears to right hand	710202.1	Unknown	Unknown
11	Skin tears to left hand	710202.1	Unknown	Unknown
12	*Abrasion to left knee	710202.1	Isolated Front – Left lower instrument panel (includes knee bolster)	Certain
13	*Abrasion to right knee	710202.1	Isolated Front – Steering column	Certain
14	*Contusion to left knee	710402.1	Isolated Front – Left lower instrument panel (includes knee bolster)	Certain
15	*Contusion to right knee	710402.1	Isolated Front – Steering column	Certain
16	*Contusion to right side of abdomen	510402.1	Isolated Interior – Lap portion of belt restraint	Certain
17	*Abrasion to right side of abdomen	510202.1	Isolated Interior – Lap portion of belt restraint	Certain

Source: Hospital records. *Interview injuries

Driver Kinematics

The 41-year-old male driver was seated with the power-adjustable seat track in the rear position. The seatback was presumed to be in a normal recline, as it was reclined post-crash during the in-vehicle assessment and extrication of the driver. The adjustable head restraint was 6 cm (2.4 in) above the seatback at the time of the SCI inspection. The driver was wearing the manual seat belt system evidenced by EDR data (buckled), loading evidence on the belt webbing, and a separation of the webbing at the area of the latch plate. The location and severity of his abdominal injuries, in addition to a subtle belt webbing mark on his torso, indicated that the shoulder belt webbing might have been positioned low on his left shoulder. The driver may have also been leaning to his right pre-crash.

The offset, head-on crash resulted in a force direction of 1 o'clock. The severity of the impact actuated the retractor and lower anchor pretensioners and deployed the driver's frontal and IC air

bags. The expanding driver's frontal air bag expanded against the anterior aspect of the driver's right forearm resulting in an abrasion. In response to the frontal crash forces, the driver initiated a forward and right trajectory and loaded the manual seat belt system. His loading force against the shoulder belt webbing produced a subtle linear-oriented mark across his lower chest/upper right abdomen, which was not documented in the medical report but described by the interview. As he continued to load the seat belt, the driver sustained multiple injuries (AIS 2 to AIS 4) to the organs in his abdomen. During this loading of the seat belt, the webbing separated at the latch plate.

The driver's knees engaged the knee bolster and the lower shielding of the steering column. His left knee deformed the bolster panel and the steel backer panel left of the steering column. The driver's right knee scuffed the underside of the steering column polymer cover. The driver stated during the SCI interview that he sustained abrasions and contusions over the knees; however, these injuries were not identified in the medical documents.

The combination of the initial seat belt loading and the driver's knee contacts to the bolster/lower instrument panel caused his head to jackknife forward and downward due to flexion of the neck. His face contacted the upper aspect of the steering wheel rim, causing a nasal bone fracture and multiple teeth fractures. The driver's torso engaged and loaded through the deployed air bag. The steering wheel flange was deformed, evidenced by closure of the gap between the steering wheel hub and the steering column cover at the lower aspect. The energy-absorbing steering wheel column was compressed, and the column was displaced vertically upward. There was no bending of the steering wheel rim.

Post-crash, the driver remained in the vehicle and was extricated by firefighters. The firefighters used rescue equipment to cut the left B-pillar from the vehicle and removed the left rear door. The driver's seatback was reclined to facilitate his removal from the GMC. He was transported by ambulance to a level 1 trauma center, where he was admitted for surgical treatment of his abdominal injuries. He was hospitalized for 17 days and discharged.

2011 Subaru Forester

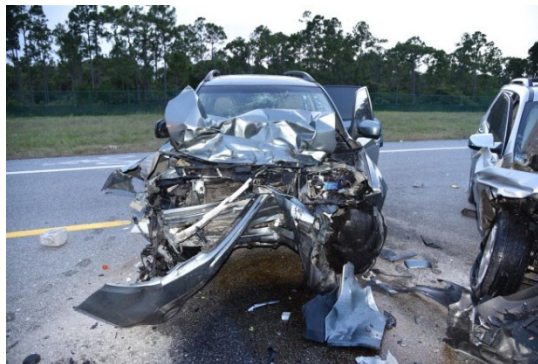
Description

The 2011 Subaru Forester had the premium trim package. The Subaru was not inspected as it was in the possession of an attorney at the time this investigation was assigned. The VIN was JF2SHBCC4BHxxxxxx. Specifications listed the Subaru as powered by a 2.5-liter, “boxer”¹ engine linked to a 4-speed automatic transmission and all-wheel drive. Additional standard features included electronic brakeforce distribution, emergency brake assist, a tire pressure monitoring system, traction control, and electronic stability control. The service brakes were hydraulic, power-assisted, 4-wheel disc with ABS. The Subaru had multi-spoke alloy wheels, and the standard tire size was 225/55R17.

The interior of the Subaru had seating for five occupants (2/3) with front-row bucket seats and a 3-passenger second row with a split, forward-folding seatback with a fold-down center armrest. All five positions had adjustable head restraints. Both front head restraints were adjusted above the seatbacks, while the positions of the second row were unknown as they were not visible in the on-scene police images. Restraint systems consisted of 3-point continuous loop lap and shoulder seat belts for the five positions. All had sliding latch plates. Supplemental restraints consisted of CAC frontal air bag for the driver and right front positions and side impact front seat-mounted and roof side rail IC air bags. The driver’s frontal air bag deployed in this crash.

Exterior Damage

The on-scene police images (Figures 17 and 18) provided the basis for the estimated damage. The exterior damage to the Subaru was distributed across the front plane. It involved damage to the bumper system, the grille, the hood, both front fenders, the upper radiator support, and the driver train, as well as fracturing of the windshield. Maximum crush was an estimated 38-51 cm (15-20 in), located at the left front corner of the bumper beam. The estimated CDC for this damage pattern was 11FDEW3. The severity of the crash calculated by the “missing vehicle” algorithm of the WinSMASH was 45 km/h (28 mph). The longitudinal and lateral velocity changes were -42 km/h (-26 mph) and 15 km/h (9 mph). These results were considered borderline and low.



*Figure 17. Frontal damage to the Subaru
(image obtained from the police)*

¹ A squat, rectangular engine configuration said to be characteristic of the Subaru brand.

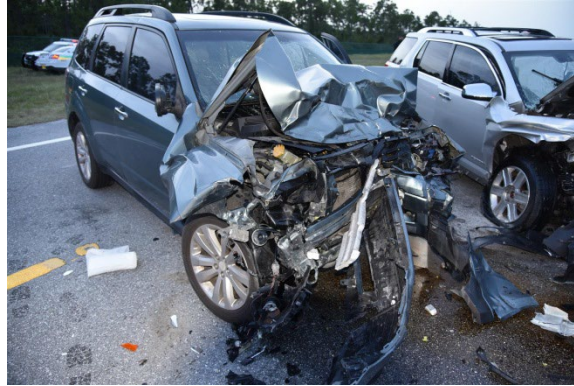
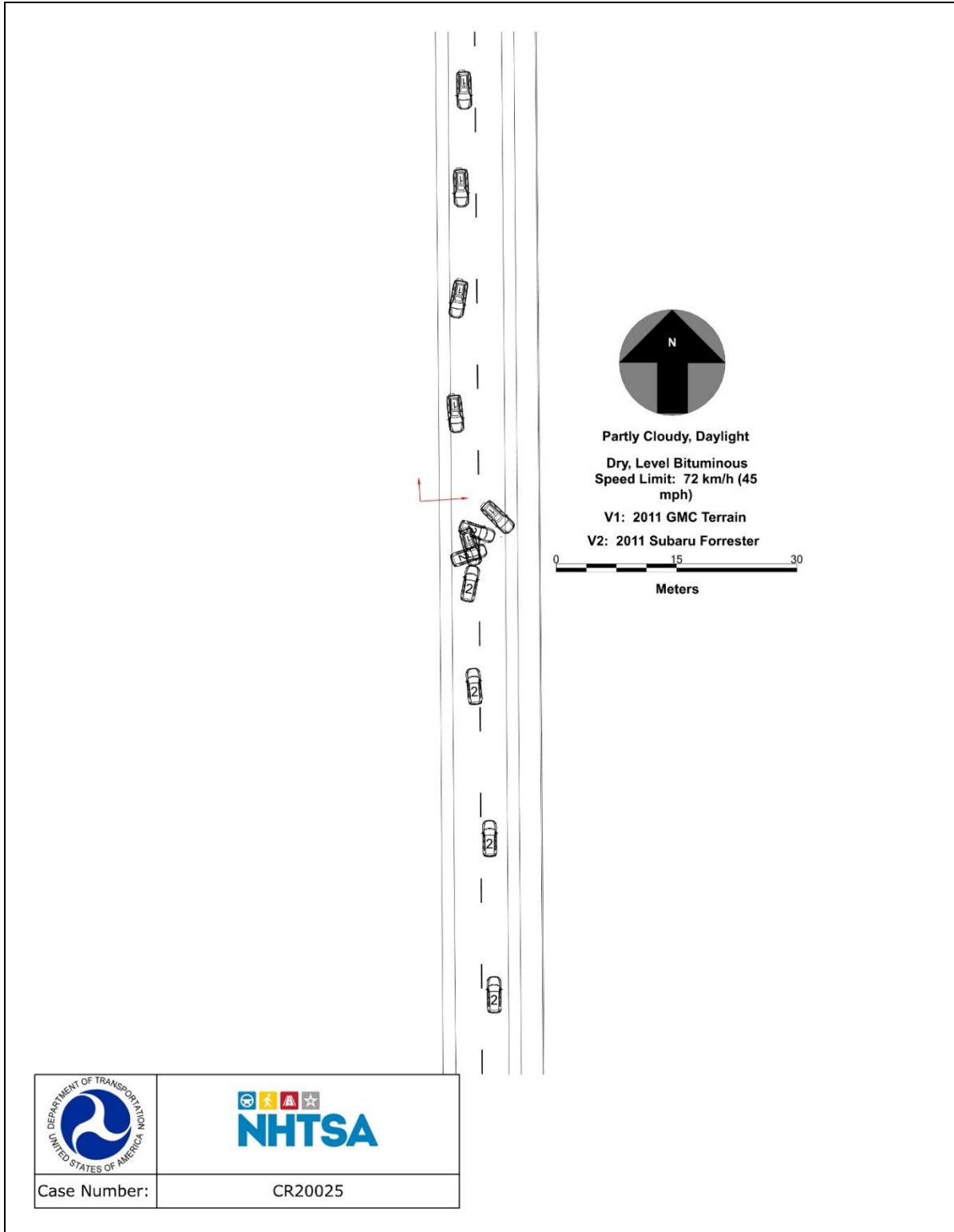


Figure 18. Front right three-quarter view of the damage to the Subaru (image obtained from the police)

Subaru Occupants

The Subaru was driven by the 39-year-old female with a 9-year-old female second-row right passenger. Both were reported by the police as seat-belted. The driver's frontal air bag deployed in the Subaru. The driver sustained police-reported B-level (non-incapacitating) injuries and was transported by ambulance for treatment. The 9-year-old second-row right passenger was removed from the vehicle and transported to a hospital, where she expired due to her injuries five days later.

Crash Diagram



Appendix A: Event Data Recorder Report for 2011 GMC Terrain²

² The EDR report contained in this technical report was imaged by the police during their investigation. That electronic file was forwarded to SCI and is reported with the version of the CDR software current at the time of this final report. It has been sanitized of personally identifiable information. 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	2CTFLWE50B6*****
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CR20025_V1_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 19.4
Imaged with Software Licensed to (Company Name)	Company Name information was removed when this file was saved without VIN sequence number
Reported with CDR version	Crash Data Retrieval Tool 21.3
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Non-Deployment, Deployment, Non-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 Events, the SDM will record 220 milliseconds of data after the Deployment criteria is met and up to 70 milliseconds before the Deployment criteria is met. For Non-Deployment Events, the SDM will record the first 300 milliseconds of data after algorithm enable.

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 Non-Deployment (Non-rollover) Events, the SDM will record 750 milliseconds of data before a calibrated angle threshold is reached. For Deployment Events, the SDM will record up to 490 milliseconds of data before the Deployment criteria is met and 250 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 CDR tool displays time from Algorithm Enable (AE) to time of Deployment command in a Deployment event and AE to

time of maximum SDM recorded vehicle velocity change in a Non-Deployment event. Time from AE begins when the first air bag system enable threshold is met and ends when Deployment command criteria is met or at maximum SDM recorded vehicle velocity change. Any air bag systems may be a source of an enable.

- Time From Algorithm Enable to Maximum SDM Recorded Vehicle Velocity Change is captured when the largest, absolute value of either the Longitudinal or Lateral Recorded Vehicle Velocity Change occurs. The Maximum may occur between the recorded 10 millisecond sample points.
- 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 AE. That is to say, the last data point may have been captured just before AE but no more than 0.5 second before AE. All subsequent Pre-crash data values are referenced from this data point.
- Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if:
 - The SDM receives a message with an "invalid" flag from the module sending the pre-crash data
- 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-Deployments, 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 deployment times for subsequent deployment type events, during the same ignition cycle, will not be recorded. Also, forced timer loops, will not be shown as being commanded to deploy. Loops without their own independent deployment calibration are called "forced timer loops." Examples of a forced timer loops are Pretensioner Deployment Loop #2 and Knee Deployment Loop.
- Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously may be reported higher than Ignition Cycles At Event because the Ignition Cycles SIR Warning Lamp was ON/OFF counter is not cleared during the vehicle build process.
- Ignition Cycles At Event may be reported higher than Ignition Cycles At Investigation by one ignition cycle. This is due to the way Ignition Cycles At Investigation is written during a vehicle power loss situation.
- The reported range of the longitudinal and lateral acceleration values is approximately ± 50 g.
- All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

Data Source:

- All SDM recorded data is measured, calculated, and stored internally, except for the following:
- Vehicle Status Data (Pre-Crash) is transmitted to the SDM, by 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 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.

01038_SDM10_SDM10i-autoliv_r025

Event Data (General)

Ignition Cycles At Investigation	12097
ESS # 1 Traceability Data	AU2577E013D68E9E
ESS # 2 Traceability Data	DA0000E000000000
ESS # 3 Traceability Data	AH2577E013DC18E6
ESS # 4 Traceability Data	AJ2577E013DC194B
ESS # 5 Traceability Data	AT2577E013D6A358
ESS # 6 Traceability Data	DB2577E013D49F85
ESS # 7 Traceability Data	000000E000000000
ESS # 8 Traceability Data	000000E000000000
Dynamic Deployment Event Counter	1
Dynamic Event Counter	3
Dynamic OnStar Notification Event Counter	1
Vehicle Identification Number	2CTFLWE50B6*****
System Type	Autoliv
Manufacturing Traceability Data	AS4893E050694612
Software Module Identifier 1	00CF22EB
Software Module Identifier 2	0140467E
Software Module Identifier 3	0189ECCF
End Model Part Number	00CF22ED

Event Data (Event Record 1)

Event Recording Complete	Yes
Event Record Type	Non-Deployment
Crash Record Locked	No
OnStar Deployment Status Data Sent	Yes
OnStar SDM Recorded Vehicle Velocity Change Data Sent	Yes
Deployment Event Counter	0
Event Counter	1
OnStar Notification Event Counter	0
Algorithm Active: Rear	Yes
Algorithm Active: Rollover	No
Algorithm Active: Side	No
Algorithm Active: Frontal	No
Ignition Cycles At Event	3810
Time Between Events (sec)	Data Not Available
Concurrent Event Flag Set	No
Event Severity Status: Rollover	No
Event Severity Status: Rear	No
Event Severity Status: Right Side	No
Event Severity Status: Left Side	No
Event Severity Status: Frontal Stage 2	No
Event Severity Status: Frontal Stage 1	No
Event Severity Status: Frontal Pretensioner	No
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	No
Right Row 1 Roof Rail/Head Curtain Loop Commanded	No
Driver Belt Switch Circuit Status	Buckled
Passenger Belt Switch Circuit Status	Buckled
Passenger Seat Occupancy Status	Occupied
Passenger Classification Status	No (Adult)
Passenger Air Bag ON Indicator Status	On
Passenger Air Bag OFF Indicator Status	Off
Low Tire Pressure Warning Lamp	Off
SIR Warning Lamp Status	Off
SIR Warning Lamp ON/OFF Time Continuously (seconds)	655330
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	236
Ignition Cycles Since DTCs Were Last Cleared at Event Enable	253
Time From Algorithm Enable to Maximum SDM Recorded Vehicle Velocity Change (msec)	110
Longitudinal SDM Recorded Vehicle Velocity Change at time of Maximum SDM Recorded Vehicle Velocity Change MPH [km/h]	6 [9]
Lateral SDM Recorded Vehicle Velocity Change at time of Maximum SDM Recorded Vehicle Velocity Change MPH [km/h]	0 [0]
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Driver Thorax/Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Passenger Thorax/Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available

Driver Pretensioner Time From Algorithm Enable to Deployment Loop #1 or Loop #2 Command Criteria Met (msec)	Data Not Available
Passenger Pretensioner Time From Algorithm Enable to Deployment Loop #1 or Loop #2 Command Criteria Met (msec)	Data Not Available

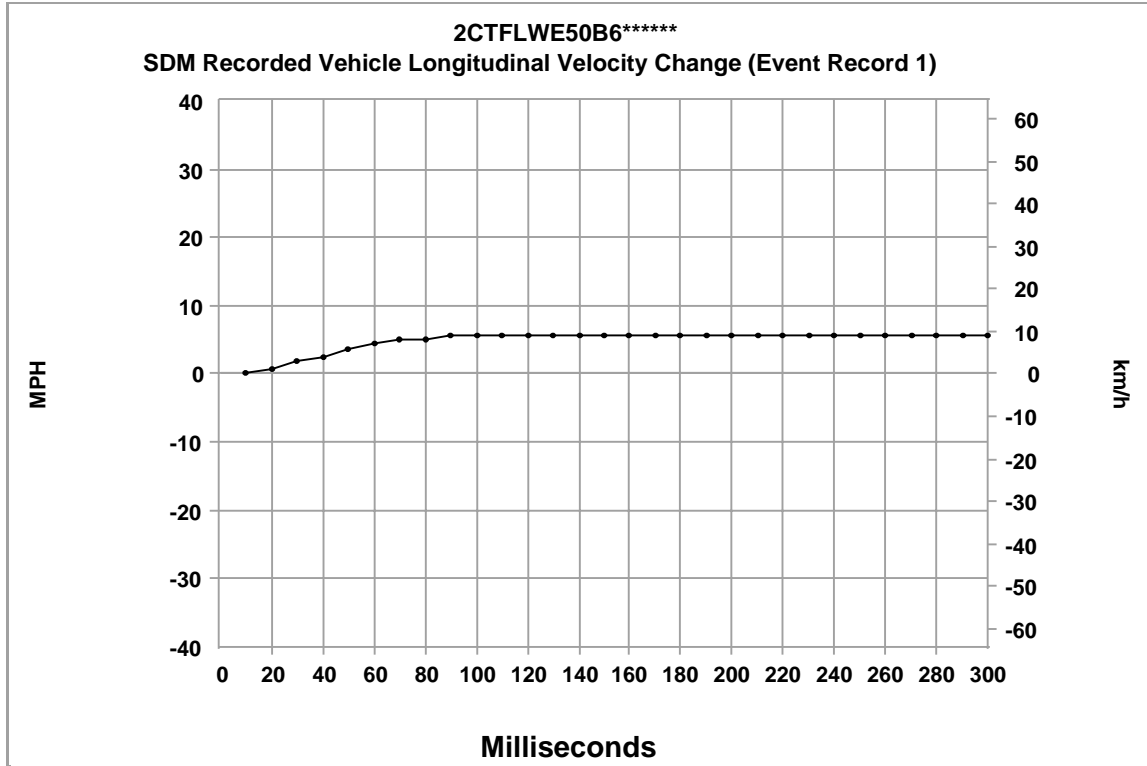
DTCs Present at Time of Event (Event Record 1)
No Diagnostic Trouble Codes

Pre-Crash Data -1 to -.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
-1.0	No	No	No	18 [24]	Off
-0.5	No	No	No	21 [28]	Off

Pre-Crash Data -2.5 to -.5 sec (Event Record 1)

Times (sec)	Accelerator Pedal Position (percent)	Brake Switch Circuit State	Engine Speed	Throttle Position (%)	Vehicle Speed (MPH [km/h])
-2.5	0	On	576	10	6 [9]
-2.0	0	On	576	11	4 [7]
-1.5	0	On	576	11	3 [5]
-1.0	0	On	576	11	2 [3]
-0.5	0	On	512	10	1 [2]



Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
10	0.0	0.0
20	0.6	1.0
30	1.9	3.0
40	2.5	4.0
50	3.7	6.0
60	4.3	7.0
70	5.0	8.0
80	5.0	8.0
90	5.6	9.0
100	5.6	9.0
110	5.6	9.0
120	5.6	9.0
130	5.6	9.0
140	5.6	9.0
150	5.6	9.0
160	5.6	9.0
170	5.6	9.0
180	5.6	9.0
190	5.6	9.0
200	5.6	9.0
210	5.6	9.0

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
220	5.6	9.0
230	5.6	9.0
240	5.6	9.0
250	5.6	9.0
260	5.6	9.0
270	5.6	9.0
280	5.6	9.0
290	5.6	9.0
300	5.6	9.0

SDM Recorded Vehicle Lateral Velocity Change (Event Record 1)

Contains No Recorded Data

SDM Recorded Vehicle Lateral Acceleration (Event Record 1)

Contains No Recorded Data

SDM Recorded Vehicle Vertical Acceleration (Event Record 1)

Contains No Recorded Data

SDM Recorded Vehicle Roll Rate (Event Record 1)

Contains No Recorded Data

Event Data (Event Record 2)

Event Recording Complete	Yes
Event Record Type	Deployment
Crash Record Locked	Yes
OnStar Deployment Status Data Sent	Yes
OnStar SDM Recorded Vehicle Velocity Change Data Sent	Yes
Deployment Event Counter	1
Event Counter	2
OnStar Notification Event Counter	1
Algorithm Active: Rear	Yes
Algorithm Active: Rollover	Yes
Algorithm Active: Side	Yes
Algorithm Active: Frontal	Yes
Ignition Cycles At Event	12097
Time Between Events (sec)	655.33
Concurrent Event Flag Set	No
Event Severity Status: Rollover	No
Event Severity Status: Rear	No
Event Severity Status: Right Side	No
Event Severity Status: Left Side	No
Event Severity Status: Frontal Stage 2	Yes
Event Severity Status: Frontal Stage 1	Yes
Event Severity Status: Frontal Pretensioner	Yes
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	Yes
Right Row 1 Roof Rail/Head Curtain Loop Commanded	Yes
Driver Belt Switch Circuit Status	Buckled
Passenger Belt Switch Circuit Status	Not Buckled
Passenger Seat Occupancy Status	Empty
Passenger Classification Status	Not Applicable
Passenger Air Bag ON Indicator Status	Off
Passenger Air Bag OFF Indicator Status	On
Low Tire Pressure Warning Lamp	Off
SIR Warning Lamp Status	Off
SIR Warning Lamp ON/OFF Time Continuously (seconds)	655330
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	204
Ignition Cycles Since DTCs Were Last Cleared at Event Enable	253
Time From Algorithm Enable to Maximum SDM Recorded Vehicle Velocity Change (msec)	90
Longitudinal SDM Recorded Vehicle Velocity Change at time of Maximum SDM Recorded Vehicle Velocity Change MPH [km/h]	-35 [-56]
Lateral SDM Recorded Vehicle Velocity Change at time of Maximum SDM Recorded Vehicle Velocity Change MPH [km/h]	-12 [-20]
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	6
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	9
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Driver Thorax/Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	108
Passenger Thorax/Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	108

Driver Pretensioner Time From Algorithm Enable to Deployment Loop #1 or Loop #2 Command Criteria Met (msec)	3
Passenger Pretensioner Time From Algorithm Enable to Deployment Loop #1 or Loop #2 Command Criteria Met (msec)	3

DTCs Present at Time of Event (Event Record 2)

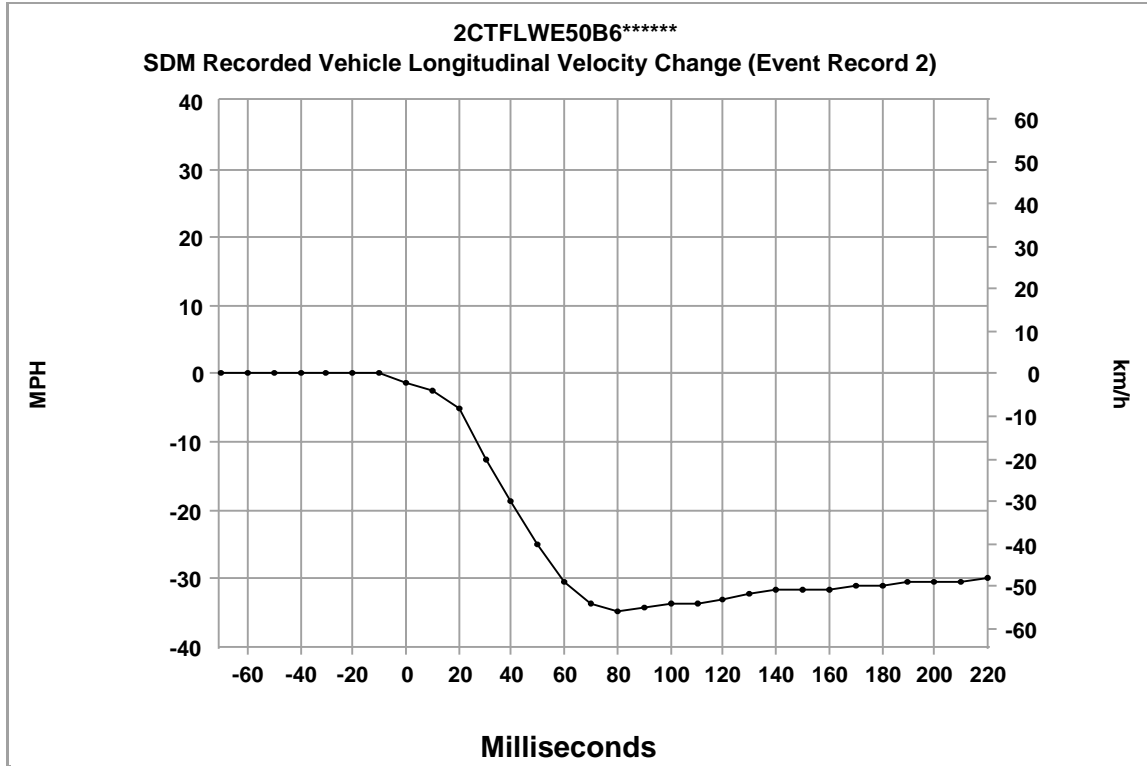
B0052-00

Pre-Crash Data -1 to -.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
-1.0	No	No	No	-32 [-44]	Off
-0.5	No	No	No	-1 [-1]	Off

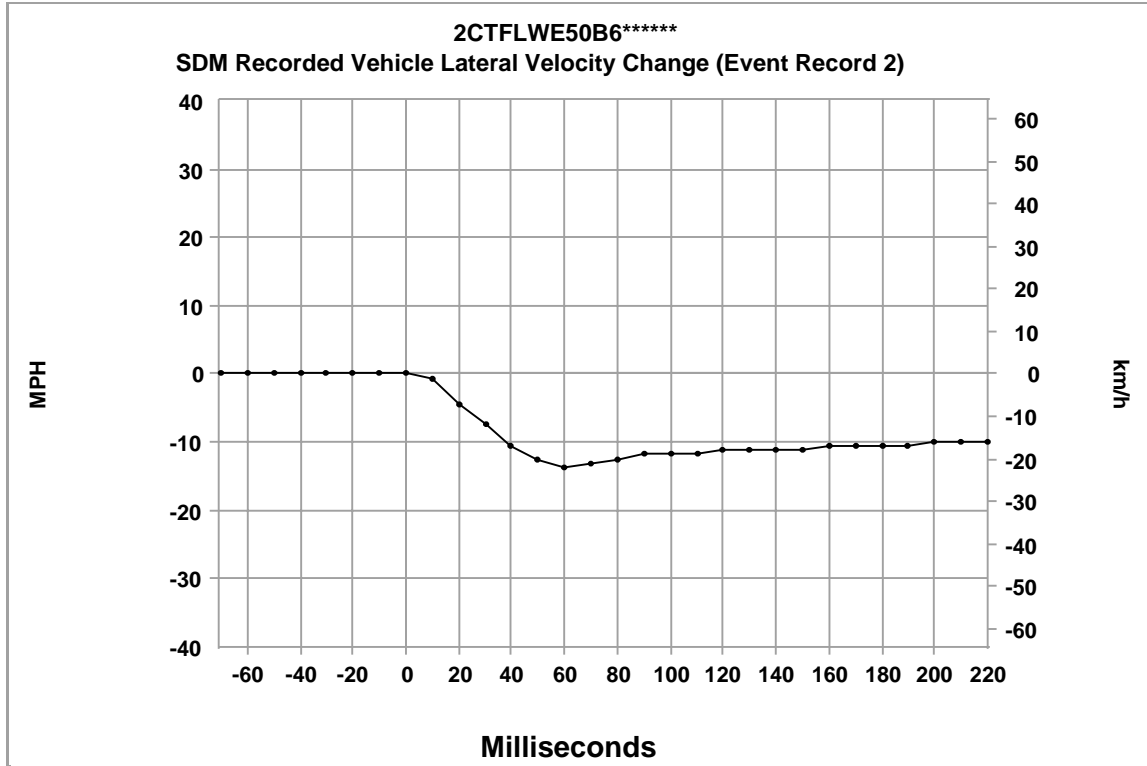
Pre-Crash Data -2.5 to -.5 sec (Event Record 2)

Times (sec)	Accelerator Pedal Position (percent)	Brake Switch Circuit State	Engine Speed	Throttle Position (%)	Vehicle Speed (MPH [km/h])
-2.5	0	On	1344	11	54 [87]
-2.0	0	On	1216	10	50 [81]
-1.5	0	On	1088	9	45 [73]
-1.0	0	On	704	14	40 [64]
-0.5	0	Off	960	14	35 [57]



Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
-70	0.0	0.0
-60	0.0	0.0
-50	0.0	0.0
-40	0.0	0.0
-30	0.0	0.0
-20	0.0	0.0
-10	0.0	0.0
0	-1.2	-2.0
10	-2.5	-4.0
20	-5.0	-8.0
30	-12.4	-20.0
40	-18.6	-30.0
50	-24.9	-40.0
60	-30.4	-49.0
70	-33.6	-54.0
80	-34.8	-56.0
90	-34.2	-55.0
100	-33.6	-54.0
110	-33.6	-54.0
120	-32.9	-53.0
130	-32.3	-52.0

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
140	-31.7	-51.0
150	-31.7	-51.0
160	-31.7	-51.0
170	-31.1	-50.0
180	-31.1	-50.0
190	-30.4	-49.0
200	-30.4	-49.0
210	-30.4	-49.0
220	-29.8	-48.0



Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
-70	0.0	0.0
-60	0.0	0.0
-50	0.0	0.0
-40	0.0	0.0
-30	0.0	0.0
-20	0.0	0.0
-10	0.0	0.0
0	0.0	0.0
10	-0.6	-1.0
20	-4.3	-7.0
30	-7.5	-12.0
40	-10.6	-17.0
50	-12.4	-20.0
60	-13.7	-22.0
70	-13.0	-21.0
80	-12.4	-20.0
90	-11.8	-19.0
100	-11.8	-19.0
110	-11.8	-19.0
120	-11.2	-18.0
130	-11.2	-18.0

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
140	-11.2	-18.0
150	-11.2	-18.0
160	-10.6	-17.0
170	-10.6	-17.0
180	-10.6	-17.0
190	-10.6	-17.0
200	-9.9	-16.0
210	-9.9	-16.0
220	-9.9	-16.0

SDM Recorded Vehicle Lateral Acceleration (Event Record 2)

Contains No Recorded Data

SDM Recorded Vehicle Vertical Acceleration (Event Record 2)

Contains No Recorded Data

SDM Recorded Vehicle Roll Rate (Event Record 2)

Contains No Recorded Data

Event Data (Event Record 3)

Event Recording Complete	Yes
Event Record Type	Non-Deployment
Crash Record Locked	No
OnStar Deployment Status Data Sent	Yes
OnStar SDM Recorded Vehicle Velocity Change Data Sent	Yes
Deployment Event Counter	1
Event Counter	3
OnStar Notification Event Counter	1
Algorithm Active: Rear	No
Algorithm Active: Rollover	Yes
Algorithm Active: Side	Yes
Algorithm Active: Frontal	No
Ignition Cycles At Event	12097
Time Between Events (sec)	0.56
Concurrent Event Flag Set	No
Event Severity Status: Rollover	No
Event Severity Status: Rear	No
Event Severity Status: Right Side	No
Event Severity Status: Left Side	No
Event Severity Status: Frontal Stage 2	No
Event Severity Status: Frontal Stage 1	No
Event Severity Status: Frontal Pretensioner	No
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	No
Right Row 1 Roof Rail/Head Curtain Loop Commanded	No
Driver Belt Switch Circuit Status	Buckled
Passenger Belt Switch Circuit Status	Not Buckled
Passenger Seat Occupancy Status	Empty
Passenger Classification Status	Not Applicable
Passenger Air Bag ON Indicator Status	Off
Passenger Air Bag OFF Indicator Status	On
Low Tire Pressure Warning Lamp	Off
SIR Warning Lamp Status	Off
SIR Warning Lamp ON/OFF Time Continuously (seconds)	655330
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	204
Ignition Cycles Since DTCs Were Last Cleared at Event Enable	253
Time From Algorithm Enable to Maximum SDM Recorded Vehicle Velocity Change (msec)	280
Longitudinal SDM Recorded Vehicle Velocity Change at time of Maximum SDM Recorded Vehicle Velocity Change MPH [km/h]	2 [3]
Lateral SDM Recorded Vehicle Velocity Change at time of Maximum SDM Recorded Vehicle Velocity Change MPH [km/h]	7 [12]
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Driver Thorax/Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available
Passenger Thorax/Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	Data Not Available

Driver Pretensioner Time From Algorithm Enable to Deployment Loop #1 or Loop #2 Command Criteria Met (msec)	Data Not Available
Passenger Pretensioner Time From Algorithm Enable to Deployment Loop #1 or Loop #2 Command Criteria Met (msec)	Data Not Available

DTCs Present at Time of Event (Event Record 3)

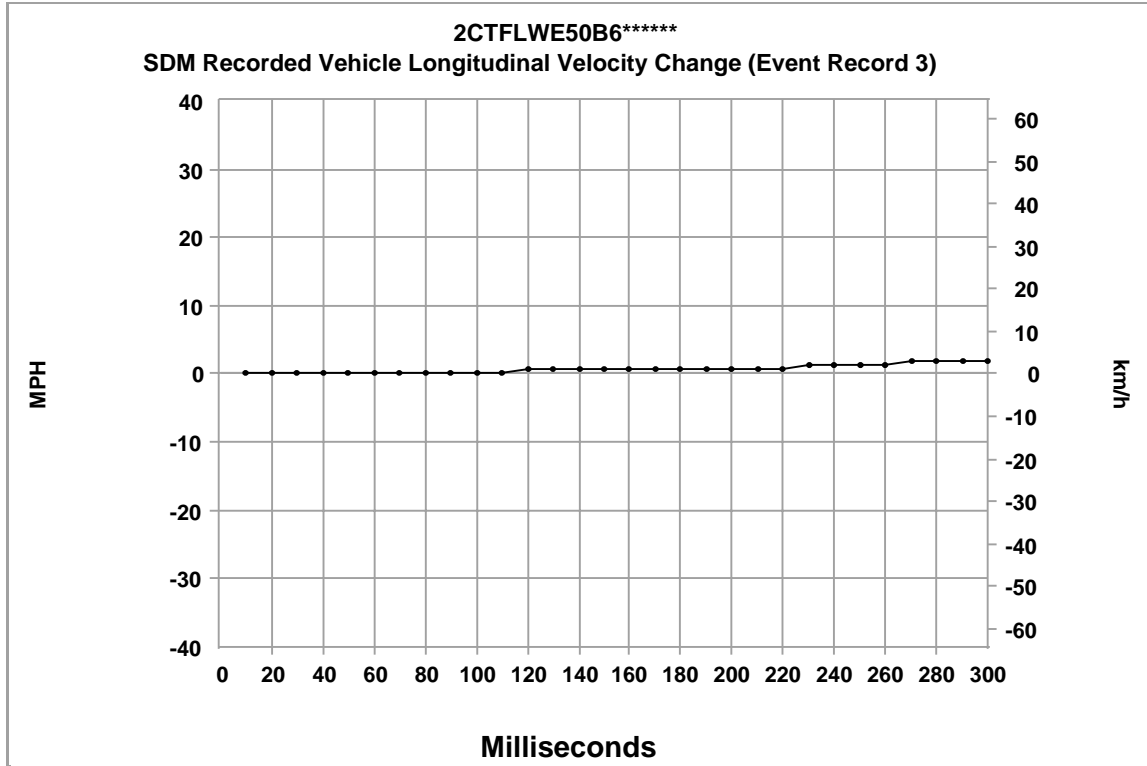
B0052-00

Pre-Crash Data -1 to -.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
-1.0	No	No	No	-1 [-1]	Off
-0.5	No	No	No	-4 [-6]	Off

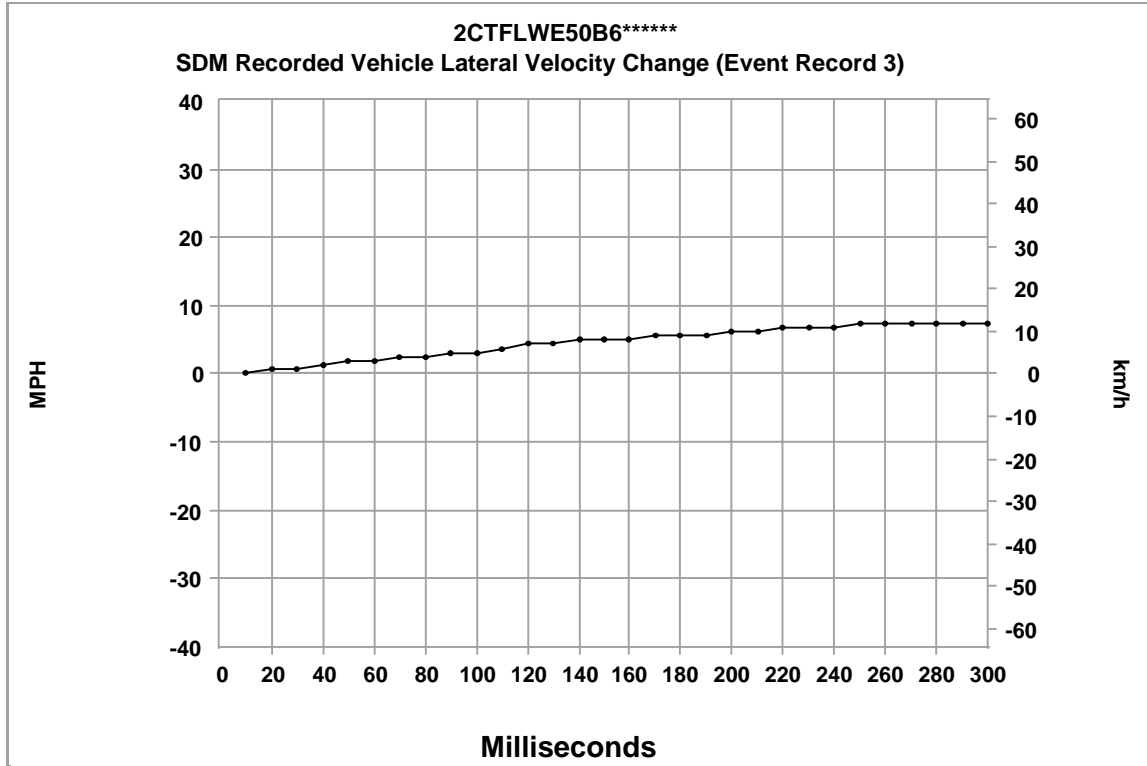
Pre-Crash Data -2.5 to -.5 sec (Event Record 3)

Times (sec)	Accelerator Pedal Position (percent)	Brake Switch Circuit State	Engine Speed	Throttle Position (%)	Vehicle Speed (MPH [km/h])
-2.5	0	On	1216	10	50 [81]
-2.0	0	On	1088	9	45 [73]
-1.5	0	On	704	14	40 [64]
-1.0	0	Off	960	14	35 [57]
-0.5	0	On	1088	12	34 [55]



Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
10	0.0	0.0
20	0.0	0.0
30	0.0	0.0
40	0.0	0.0
50	0.0	0.0
60	0.0	0.0
70	0.0	0.0
80	0.0	0.0
90	0.0	0.0
100	0.0	0.0
110	0.0	0.0
120	0.6	1.0
130	0.6	1.0
140	0.6	1.0
150	0.6	1.0
160	0.6	1.0
170	0.6	1.0
180	0.6	1.0
190	0.6	1.0
200	0.6	1.0
210	0.6	1.0

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
220	0.6	1.0
230	1.2	2.0
240	1.2	2.0
250	1.2	2.0
260	1.2	2.0
270	1.9	3.0
280	1.9	3.0
290	1.9	3.0
300	1.9	3.0



Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
10	0.0	0.0
20	0.6	1.0
30	0.6	1.0
40	1.2	2.0
50	1.9	3.0
60	1.9	3.0
70	2.5	4.0
80	2.5	4.0
90	3.1	5.0
100	3.1	5.0
110	3.7	6.0
120	4.3	7.0
130	4.3	7.0
140	5.0	8.0
150	5.0	8.0
160	5.0	8.0
170	5.6	9.0
180	5.6	9.0
190	5.6	9.0
200	6.2	10.0
210	6.2	10.0

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
220	6.8	11.0
230	6.8	11.0
240	6.8	11.0
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

SDM Recorded Vehicle Lateral Acceleration (Event Record 3)

Contains No Recorded Data

SDM Recorded Vehicle Vertical Acceleration (Event Record 3)

Contains No Recorded Data

SDM Recorded Vehicle Roll Rate (Event Record 3)

Contains No Recorded Data

Hexadecimal Data

DPID \$11
FF F0 00 FC C0 7C 00

DPID \$15
01 02 03 04 05 06 07

DPID \$16
08 09 0A 0D 0E 00 00

DPID \$17
00 00 00 00 00 00 00

DPID \$32
00 FD 2F 41 00 00 00

DPID \$35
78 00 00 00 00 00 00

DID \$01
41 55 32 35 37 37 45 30 31 33 44 36 38 45 39 45

DID \$03
44 41 30 30 30 30 45 30 30 30 30 30 30 30 30 30

DID \$05
41 48 32 35 37 37 45 30 31 33 44 43 31 38 45 36

DID \$07
41 4A 32 35 37 37 45 30 31 33 44 43 31 39 34 42

DID \$09
41 54 32 35 37 37 45 30 31 33 44 36 41 33 35 38

DID \$0B
44 42 32 35 37 37 45 30 31 33 44 34 39 46 38 35

DID \$0D
30 30 30 30 30 30 45 30 30 30 30 30 30 30 30 30

DID \$0F
30 30 30 30 30 30 45 30 30 30 30 30 30 30 30 30

DID \$30
01 00 03 01

DID \$90
32 43 54 46 4C 57 45 35 30 42 36 2A 2A 2A 2A 2A

DID \$9A
04 01

DID \$B4
41 53 34 38 39 33 45 30 35 30 36 39 34 36 31 32

DID \$C1
00 CF 22 EB

DID \$C2
01 40 46 7E

DID \$C3

01 89 EC CF

DID \$CB
00 CF 22 ED

DID \$31

```
0000 A5 30 00 00 01 00 08 0E E2 FF
0010 FF 00 00 00 00 00 00 00 00 00
0020 5C FC FC F0 20 60 C0 40 00 00
0030 00 00 00 55 40 00 00 08 09 09
0040 09 09 06 D9 06 D0 0A 0B 0B 0B
0050 0A 02 03 05 07 09 00 FF FD 00
0060 EC FD 00 00 00 00 00 00 00 00
0070 00 00 00 00 00 00 00 00 00 00
0080 00 00 00 00 00 00 00 00 00 0B
0090 88 7F FF FF FF FF FF FF FF FF
0100 7F 7F 80 7F 82 7F 83 7F 85 7F
0110 86 7F 87 7F 87 7F 88 7F 88 7F
0120 88 7F 88 7F 88 7F 88 7F 88 7F
0130 88 7F 88 7F 88 7F 88 7F 88 7F
0140 88 7F 88 7F 88 7F 88 7F 88 7F
0150 88 7F 88 7F 88 7F 88 7F 88 7F
0160 7D 7D 7F 7D 7D 7F 7D 7D 7F 7D
0170 7D 7F 7D 7D 7F 7D 7D 7F 7D 7D
0180 7F 7D 7D 7F 7D 7D 7F 7D 7D 7F
0190 7D 7D 7F 7D 7D 7F 7D 7D 7F 7D
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0210 7F 7D 7D 7F 7D 7D 7F 7D 7D 7F
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0280 7D 7D 7F 7D 7D 7F 7D 7D 7F 7D
0290 7D 7F 7D 7D 7F 7D 7D 7F 7D 7D
0300 7F 7D 7D 7F 7D 7D 7F 7D 7D 7F
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0360 7F 7D 7D 7F 7D 7D 7F 7D 7D 7F
0370 7D 7D 7F 7D 7D 7F 7D 7D 7F 7D
0380 7D 7F 7D 7D 7F 00 00 00 00 00
0390 00 00 00 00 00 00 00 00 00 00
0400 00 00 00 00 00 00 00 00 00 00
0410 00 00 00 00 00 00 00 00 00 00
0420 00 00 00 00 00 00 00 00 00 00
0430 00 00 00 00 00 00 00 00 00 00
0440 00 00 00 00 00 00 00 00 00 00
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0470 00 00 00 00 00 00 00 00 00 00
0480 00 00 00 00 00 00 00 00 00 00
0490 00 00 00 00 00 00 00 00 DB 19
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DID \$32

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0030 00 00 00 15 40 00 00 0F 0B 11
0040 13 15 06 9E 06 49 0E 0E 09 0A
```

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0050 0B 39 40 49 51 57 00 FF FD 00
0060 CC FD 00 00 00 00 00 00 00 00
0070 00 00 00 00 00 00 00 00 00 00
0080 00 00 00 00 00 00 80 52 00 09
0090 47 6B 02 03 FF FF 24 24 01 01
0100 7F 7F 7F 7F 7F 7F 7F 7F 7F 7F
0110 7F 7F 7F 7F 7D 7F 7B 7E 77 78
0120 6B 73 61 6E 57 6B 4E 69 49 6A
0130 47 6B 48 6C 49 6C 49 6C 4A 6D
0140 4B 6D 4C 6D 4C 6D 4C 6E 4D 6E
0150 4D 6E 4E 6E 4E 6F 4E 6F 4F 6F
0160 7D 7D 7F 7D 7D 7F 7D 7D 7F 7D
0170 7D 7F 7D 7D 7F 7D 7D 7F 7D 7D
0180 7F 7D 7D 7F 7D 7D 7F 7D 7D 7F
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0210 7F 7D 7D 7F 7D 7D 7F 7D 7D 7F
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0240 7F 7D 7D 7F 7D 7D 7F 7D 7D 7F
0250 7D 7D 7F 7D 7D 7F 7D 7D 7F 7D
0260 7D 7F 7D 7D 7F 7D 7D 7F 7D 7D
0270 7F 7D 7D 7F 7D 7D 7F 7D 7D 7F
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0370 7D 7D 7F 7D 7D 7F 7D 7D 7F 7D
0380 7D 7F 7D 7D 7F 00 10 00 00 00
0390 21 00 21 70 02 04 06 00 11 00
0400 0E 0D FA 00 20 00 00 00 21 00
0410 21 70 02 04 06 00 11 00 0E 0D
0420 FA 00 30 00 00 00 21 00 21 70
0430 02 04 06 00 11 00 0E 0D FA 00
0440 40 00 00 00 21 00 21 70 00 00
0450 00 00 00 00 00 00 00 00 00 00
0460 00 00 00 00 00 00 00 00 00 00
0470 00 00 00 00 00 00 00 00 00 00
0480 00 00 00 00 00 00 00 00 00 00
0490 00 00 00 00 00 00 00 00 CC 19
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DID \$33

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0000 A5 30 01 00 03 01 06 2F 41 00
0010 38 00 00 00 00 00 00 00 00 00
0020 4C FC FC F0 00 00 C0 10 00 00
0030 00 00 00 45 40 00 00 11 0F 0B
0040 11 13 06 95 06 9E 0C 0E 0E 09
0050 0A 37 39 40 49 51 00 FF FD 00
0060 CC FD 00 00 00 00 00 00 00 00
0070 00 00 00 00 00 00 00 00 00 00
0080 00 00 00 00 00 00 80 52 00 1C
0090 82 8B FF FF FF FF FF FF FF FF
0100 7F 7F 7F 80 7F 80 7F 81 7F 82
0110 7F 82 7F 83 7F 83 7F 84 7F 84
0120 7F 85 80 86 80 86 80 87 80 87
0130 80 87 80 88 80 88 80 88 80 89
0140 80 89 80 8A 81 8A 81 8A 81 8B
0150 81 8B 82 8B 82 8B 82 8B 82 8B
0160 7D 7D 7F 7D 7D 7F 7D 7D 7F 7D
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0180	7F	7D	7D	7F	7D	7D	7F	7D	7D	7F
0190	7D	7D	7F	7D	7D	7F	7D	7D	7F	7D
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0210	7F	7D	7D	7F	7D	7D	7F	7D	7D	7F
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0490	00	00	00	00	00	00	00	00	DB	19

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April 2022



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

