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Special Crash Investigations On-Site Rollover Crash Investigation Vehicle: 2015 Ford Explorer Location: New York Crash Date: September 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 opf a two-vehicle intersection/rollover crash of a 2015 Ford Explorer and the deployment of its right front seat-mounted side impact and both inflatable curtain (IC) air bags. The IC air bags complied with Federal Motor Vehicle Safety Standard (FMVSS) No. 226. This standard established requirements for ejection mitigation systems to reduce the likelihood of complete and partial ejections of vehicle occupants through side windows during rollovers or side impact events.

The crash occurred when the front plane of a northbound 2002 Oldsmobile Bravada struck the right plane of the eastbound Ford. The force of this impact, located on the Ford's right rear axle, caused the Ford's seat belt pretensioners, the front row right seat-mounted side-impact IC air bags to deploy. The impact also caused the Ford to initiate a clockwise rotation, as it separated from the Oldsmobile on a northeasterly trajectory. The Ford departed the north road edge, where it subsequently tripped into a right-side-leading multiple quarter-turn rollover event. The Ford was occupied by a belted 35-year-old female driver, a belted 70-year-old female front row right occupant and two children restrained by child restraint systems (CRSs) in the second row. None of the Ford's occupants required medical treatment. The Oldsmobile fled the scene and was found abandoned two days post-crash.

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SCI CASE NO: CR16027
ON-SITE ROLLOVER CRASH INVESTIGATION
VEHICLE: 2015 FORD EXPLORER
LOCATION: NEW YORK
CRASH DATE: SEPTEMBER 2016

BACKGROUND

This report documents the-site investigation of a two-vehicle intersection/rollover crash of a 2015 Ford Explorer (**Figure 1**) and the deployment of its right front seat-mounted side impact and both inflatable curtain (IC) air bags. The IC air bags were determined to comply with Federal Motor Vehicle Safety Standard (FMVSS) No. 226, which established requirements for ejection mitigation systems to reduce the likelihood of complete or partial ejection of vehicle occupants through side windows during rollovers or side impact events.

Figure 1: Right side view of the 2015 Ford Explorer

The crash occurred when the front plane of a northbound 2002 Oldsmobile Bravada struck the right plane of the eastbound Ford. The force of this impact, located on the Ford's right rear axle, caused the actuation of the Ford's seat belt pretensioners and the deployment of the front row right seat-mounted side-impact and both IC air bags. The impact also caused the Ford to initiate a clockwise rotation, as it separated from the Oldsmobile on a northeasterly trajectory. The Ford departed the north road edge, where it subsequently tripped into a right-side-leading multiple quarter-turn rollover event. The Ford was occupied by a belted 35-year-old female driver, a belted 70-year-old female front row right occupant, and two children restrained by child restraint systems (CRSs) in the second row. None of the Ford's occupants required medical treatment. The Oldsmobile fled the scene and was found abandoned two days after the crash.

The Ford was identified by the Special Crash Investigations (SCI) team during a routine online review of vehicles located at an insurance vehicle salvage facility in October 2016, and notification was sent to NHTSA's Crash Investigation Division (CID). The SCI team obtained a police crash report (PAR) and the CID assigned an on-site investigation. The on-site portion of this investigation occurred in October of 2016, and involved the inspection and measurement of the Ford's exterior and interior damage, an assessment of the manual and supplemental restraint systems, and the identification of possible occupant contact points. During the vehicle inspection process, data was imaged from the vehicle's event data recorder (EDR) via the Bosch Crash Data Retrieval (CDR) scan tool. The crash site was documented and the Ford's driver was interviewed.

The police report indicated that the Oldsmobile was unregistered and uninsured. Its location at the time of the SCI investigation could not be determined; therefore, it was not inspected. Photographs of the Oldsmobile found on an internet news site provided documentation of its exterior damage.

CRASH SUMMARY

Crash Site

This two-vehicle multi-event crash occurred during daylight in September 2016 at a four-leg intersection formed by a two-lane east/west road and a two-lane north/south road in a rural setting. The police-reported environmental conditions at the time of the crash were clear, daylight, and dry. The National Weather Service reported a temperature of 25.5 ºC (78.0 ºF), a relative humidity of 69 percent, 9.5 km/h (15 mph) south-southwest winds and scattered clouds. A crash diagram is included at the end of this report.

The physical environment of the crash site was documented during the SCI inspection using a Nikon Nivo 5.M+ total station. The roads and surrounding terrain were generally level in the area of the intersection. Each road was straight and was constructed of asphalt. The Ford was traveling in east on an approach to the intersection while the Oldsmobile was traveling in north (**Figures 2 and 3**).

Figure 2: East-looking trajectory view of the Ford approaching the intersection.

Figure 3: North-looking trajectory view of the Oldsmobile approaching the intersection.

The eastbound travel lane was 4.5 m (14.8 ft) in width while the adjacent westbound lane was 4 m (13.1 ft) wide. A double yellow centerline separated the east/westbound travel lanes. Both road edges were bordered by stone shoulders. A parking lot to a commercial agricultural facility was located at the southwest corner of the intersection. There were no regulatory traffic controls for north/southbound traffic flow through the intersection. The roadside at the northeast quadrant of the intersection consisted of tall cut grass and contained a residential driveway, several large diameter trees, and a fire hydrant. None of these roadside objects were involved in the crash. The northbound travel lane was 4.4 m (14.4 ft) in width and the southbound lane was 4.7 m (15.4 ft) wide. Narrow stone shoulders bordered both road edges. A painted double yellow centerline separated the travel lanes. Stop signs controlled north and southbound traffic flow through the intersection. The posted speed limit for both roadways was 89 km/h (55 mph).

Pre-Crash

The driver of the 2015 Ford was traveling in an easterly direction with the adult front right passenger and her two children secured in CRSs in the second row. In her interview, the driver reported that they had just left their home located approximately 1.6 km (1 mile) west of the crash site and had been en route approximately 1 minute. The Ford was traveling at an EDR-recorded speed of 103 to 105 km/h (64 to 65 mph) during the 5-second pre-crash recording window. As the driver approached the intersection, she stated that she detected the Oldsmobile immediately prior to impact and realized it was not going to stop at the intersection. The driver stated that she thought she applied the brakes and horn, but did not have time to steer. The imaged EDR data did not record any application of the brakes; however, the EDR data did indicate that the driver steered counterclockwise in an avoidance action. The steering application began 0.7 seconds prior to algorithm enable (AE).

The driver of the Oldsmobile was traveling north on the two-lane road at an unknown speed. The vehicle was not registered or insured and the driver subsequently fled the scene; therefore his specific actions pre-crash are unknown. There was no physical evidence at the crash site to support braking by the driver of the Oldsmobile.

Crash

The front plane of the Oldsmobile struck the right plane of the Ford (Event 1) as the vehicles passed through the center of the intersection (**Figure 4**). There was no physical evidence at the scene to identify the specific point of impact. The direct contact damage on the Ford began at the mid-point of the right front door and extended rearward to the right rear corner. The directions of force for this event were in the 2 o'clock sector for the Ford and 11 o'clock sector for the Oldsmobile. The force of the impact caused the Ford's front seat belt pretensioners and front row right seat-mounted side-impact and both IC air bags to actuate. The crash fractured the right rear suspension of the Ford, which resulted in the complete separation of the right rear wheel assembly and drive axle.

Figure 4: East trajectory view of the Ford at the point of impact.

The impact force, located aft of the Ford's center of mass, induced a clockwise rotation to the vehicle as it separated from the Oldsmobile and traversed the intersection on an east-northeast trajectory. The Ford's trajectory was evidenced by two tire marks that crossed the centerline and were directed toward the north road edge. The tire marks were attributed to the front tires of the Ford, which had rotated approximately 150 degrees at this time.

Figure 5 depicts the tire marks in the area of the Ford's approximate 150-degree rotation. The Ford then departed the road and entered the north roadside 33.6 m (110.2 ft) from the intersection impact. It continued to rotate clockwise evidenced an arcing furrow mark attributed to the right front tire. The tire mark on the roadside measured 17.5 m (57.4 ft) in length.

Figure 5: East-northeast–looking view of the tire marks along the Ford's post-crash trajectory.

Figure 6: East-looking post-impact trajectory view of the Ford approaching the driveway and rollover.

As the Ford reached approximately 245 degrees of rotation, in a near broadside attitude at the edge of a gravel driveway (**Figure 6**), the vehicle overturned due to its instability into a right side leading (Event 2). The Ford rolled about its longitudinal axis for nine quarter-turns over an uninterrupted distance of 29.6 m (97.1 ft) coming to rest in the grassy open field located east of the driveway. At rest, the vehicle was located approximately 8.8 m (28.9 ft) north of the road edge (**Figures 7 and 8**)

Figure 7: Southwest-looking view from the approximate final rest location of the Ford toward the intersection.

Figure 8: South-looking on-scene image of the Ford at final rest. Image supplied by an Internet news source.

The driver of the Oldsmobile continued north through the intersection as it remained on the road surface. The engine remained running and the driver fled the scene of the crash. He continued to travel northbound and abandoned the vehicle several miles from the crash site in a marshy area. The Oldsmobile was found two days after the crash through the efforts of the police investigation.

Post-Crash

The Ford came to rest on its right plane facing north 75.8 m (248.7 ft) from the intersection impact. Passers-by stopped at the crash site and offered assistance to the occupants of the Ford. They pulled open the fractured laminate of the windshield and assisted the driver and front row right passenger from the vehicle. The second row right occupant unbuckled her seat belt and unbuckled the harness system of the second row left CRS. The passers-by were able to open the rear lift gate of the Ford and directed the children from the vehicle through the lift gate opening. The driver and front row right passenger assessed their conditions and that of the children. All were deemed to be not injured. Police, fire, and emergency medical services (EMS) personnel responded to the crash site. The occupants of the Ford refused medical treatment and transport. They called family members for assistance and were transported from the scene by a private vehicle. The Ford was turned upright and towed from the scene. It was subsequently transferred to a regional insurance salvage yard, where it was inspected for this investigation. The Oldsmobile was recovered by the police and towed to a local tow yard. The vehicle was released prior to the assignment of this SCI investigation and was available for inspection.

2015 FORD EXPLORER

Description

The 2015 Ford Explorer XLT was a 4-door sport utility vehicle (SUV) manufactured in October 2014 and identified by the Vehicle Identification Number 1FM5K8D85FGxxxxxx (**Figure 9**). The vehicle was configured on a 287 cm (113.0 in) wheelbase. Powered by a 3.5-liter V-6 flex-fuel gasoline engine, the 6-speed automatic transmission transferred power to the all-wheel drive platform. Standard equipment included Ford's post-collision safety system, electronic stability control, a tire pressure monitoring system (TPMS), and traction control.

Figure 9: Right rear oblique view of the Ford.

The service brakes were power-assisted 4-wheel disc with ABS. The gross vehicle weight rating (GVWR) was 2,775 kg (6,120 lb) with gross axle weight ratings (GAWR) of 1,397 (3,080 lb) front and 1,497 kg (3,300 lb) rear. The curb weight was 2,146 kg (4,732 lb). The Ford was equipped with Michelin Latitude Touring all-season tires of the vehicle manufacturer's P245/60R18 recommended size that were mounted on multi-spoke alloy wheels. All tires were identified by Tire Identification Number (TIN) AP4A KAMX 4014. The vehicle manufacturer recommended tire pressure for both axles was 240 kPa (35 psi).

Specific tire data measured at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measure Tread Depth	Restricted	Damage
LF	310 kPa (45 psi)	6 mm (8/32 in)	No	None
LR	Tire flat	6 mm (7/32 in)	No	None (grass embedded into bead)
RR	Tire flat	6 mm (7/32 in)	N/A	Wheel assembly separated, rim deformed
RF	Tire flat	6 mm (8/32 in)	No	None (debeaded)

The interior of the Ford was configured for seating of seven occupants. It consisted of front row bucket seats, a split forward-folding three-occupant second row bench seat, and a split forward-folding two-occupant third row bench seat. All seven positions were equipped with adjustable head restraints. The driver's was adjusted 5 cm (2.0 in) above the seat back, the front right passenger's was 9 cm (3.5 in) above the seat back, and the second and third row head restraints were in the full-down positions. Safety systems consisted of 3-point manual lap and shoulder seat belts for the seven seat positions with frontal Certified Advanced 208-Compliant (CAC) air bags, front seat belt pretensioners, front row seat-mounted side impact air bags, and dual-sensing (side impact and rollover) IC air bags that provided protection for all three rows.

Exterior Damage

The Event 1 damage was located on the Ford's right plane and began at the midpoint of the right front door 119 cm (47.0 in) aft of the right front axle (**Figure 10**). The forward momentum of the Ford (relative to the front plane of the Oldsmobile) resulted in sideswipe-type damage that extended 229 cm (60.0in) rearward across the right rear door to the lower C-pillar. The damage pattern then changed to lateral crush over a 99 cm (39.0 in) length from the lower C-pillar to the rear corner as the vehicles reached maximum engagement. The right rear suspension fractured and the wheel assembly separated as a result of the impact.

Figure 10: Right side view of the Ford depicting the impact damage associated with Event 1.

The combined length of the direct and induced damage measured was 252 cm (99.0 in). The residual crush profile was as follows: C1 = 26 cm (10.2 in), C2 = 29 cm (11.4 in), C3 = 14 cm (5.5 in), C4 =5 cm (1.6 in), C5 =1 cm (0.4 in), C6 = 0. A complete analysis of this impact was outside of the scope of the WinSMASH program due to the non-central location of the impact beyond the occupant compartment, the corresponding lack of vehicle stiffness data at that location, and the lack of a common velocity between the vehicles during the impact.

However, for comparative purposes, a borderline analysis using the WinSMASH Missing Algorithm was calculated. This yielded the following results: the total velocity change (delta-V) of the Ford was 17 km/h (10.6 mph), with longitudinal and lateral components of -11 km/h (-6.8 mph) -13 km/h (-8.1 mph), respectively. The maximum longitudinal and lateral delta-V components recorded by the EDR were -9.93 km/h (-6.17 mph) and -10.75 km/h (-6.65 mph), respectively. The Collision Deformation Classification (CDC) assigned to the damage pattern was 02RZEW3.

The Event 2 rollover resulted in damage to the right, top and left planes of the Ford (**Figure 11**). The aft aspect of the right roof side rail was abraded and crushed from contact with the stone driveway during the first-quarter turn of the rollover sequence. The damage continued onto the right load bar of the OEM roof rack. Minor abrasions with deformation were present to the mid-aspect of the roof between the C- and D- pillars. This did not result in intrusion of the passenger compartment.

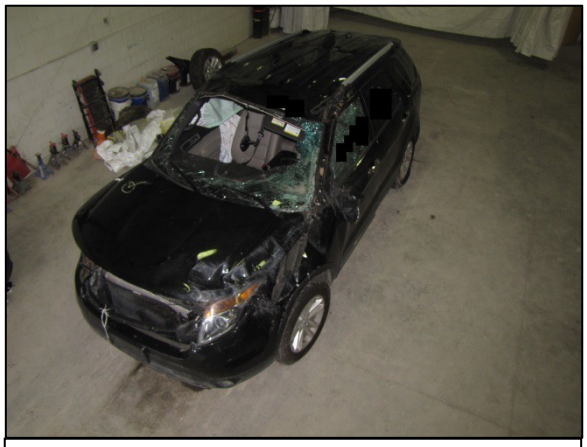


Figure 11: Overhead view of the Ford.

The left upper A-pillar struck the ground during the third quarter-turn causing lateral displacement of the pillar and an upward bucking of the windshield header. The pillar displacement fractured the windshield and resulted in a bond separation. The maximum lateral and vertical deformation was located at the left A-pillar/header juncture and measured 10 cm (4.0 in) and 8 cm (3.0 in), respectively. Scattered abrasions were present on both side planes with the heaviest concentration located at the left side of the hood and the left front fender areas. This abrasion pattern measured 157 cm (62 in) in length from the hood's left front corner extending onto the left door with lateral deformation of 15 cm (6.0 in). The left fender deformed vertically 10 cm (4.0 in). Both outside mirrors were fractured from their bases. The CDC descriptive of this damage was 00RDAO3.

The doors and lift gate of the vehicle remained closed during the crash sequence and were operational post-crash. All windows were fully closed at the time of the crash. The front doors were configured with laminated AS2 glazing. The left front door glazing was 100 percent fractured, but remained in place. The right front door glazing was not damaged. Each second row door was configured with deep-tint tempered AS3 glazing with an operable panel and a fixed panel at the aft aspect. All second row glazing remained intact. Third row glazing consisted of fixed deep-tint, tempered AS3 glass. The left plane quarter window remained intact while the right plane glazing was disintegrated. The AS3 fixed glazing of the backlight remained intact.

Event Data Recorder

The 2015 Ford Explorer was equipped with a restraints control module (RCM) that controlled the diagnostic, sensing and deployment of the vehicle's supplemental safety systems. The RCM was located on the centerline of the vehicle below the instrument stack and it had EDR capabilities. The EDR data was imaged at the time of the SCI inspection by software version 17.0 of the Bosch CDR tool via the Diagnostic Link Connector (DLC) and with 12-volt electrical power supplied through the vehicle's intact electrical system. The imaged data was reported with software version 17.7.1, included at the end of this report as **Appendix A**.

The data limitations stated that the EDR was capable of recording both Non-Deployment and Deployment events. A Non-Deployment event was not considered severe enough to warrant the deployment of an air bag device and could be overwritten. Deployment events by definition commanded the deployment of an air bag. A Deployment event became locked and could not be overwritten. The EDR could store up to two crash events. Each event was characterized by the recording of the bi-directional velocity change and roll angle crash pulse data. The velocity change data was graphically displayed for 250 milliseconds and analyzed for 300 milliseconds after AE. The rollover data was graphically displayed for a total of 6 seconds, 1 second prior to AE and 5 seconds after AE. A 5-second pre-crash buffer that described various vehicle performance parameters (including vehicle speed, accelerator pedal position, brake status, engine performance) was recorded for each event record. These performance parameters were recorded in 0.5-second intervals. Additionally, a 5-second pre-crash buffer of steering wheel angle data and high frequency stability control data was also recorded. This high frequency data was recorded in 0.1- second intervals.

The title page of the imaged data indicated that a locked side event and a locked rollover event were recorded. These two recorded events, termed "First Record" and "Second Record," both occurred on Ignition Cycle 2,919. The data was imaged on Ignition Cycle 2,922. The discrepancy in the ignition cycle count was attributed to the towing, movement and preparing the vehicle for auction. Both events were completely recorded. The data in both records indicated that the seat belt for the driver and front passenger was buckled. A data field in the Second Record reported that the time between the recorded events was 2100 milliseconds.

First Record

This record was a right-side impact event and was attributed to the intersection impact (Event 1). At the time of this recording, the air bag warning lamp was Off and there were no diagnostic trouble codes (DTC). The force of the crash resulted in the actuation of the seat belt retractor pretensioners and the deployment of the IC air bags and the right-side impact air bag. The actuation/deployments of these supplemental systems were all commanded at 49.0 milliseconds after AE. The maximum recorded longitudinal delta-V was -9.93 km/h (-6.17 mph) at 300 milliseconds. The maximum recorded lateral delta-V was -10.70 km/h (-6.65 mph) at 90 milliseconds. The key-on timer at AE was 190 seconds. This value was consistent with the driver' s interview that the vehicle had been in motion for approximately 1 minute prior to the crash.

The recorded pre-crash data indicated that the Ford approached Event 1 at a relatively constant speed of 103 to 105 km/h (64 to 65 mph). The driver released the accelerator approximately 2.0 seconds prior to AE and the vehicle coasted toward the intersection. The driver stated she was aware that the impending crash would occur based on her observation that the approaching Oldsmobile was not going to stop at the intersection. The driver's recollection was that she applied the brakes and sounded the horn immediately prior to the crash. She did not recall steering. The recorded data indicated that the driver began to steer left (CCW) 0.8 seconds prior to AE. A brake application was not recorded. The time history of data elements from the 5-second low-frequency pre-crash data table and the high-frequency steering wheel angle data are shown below.

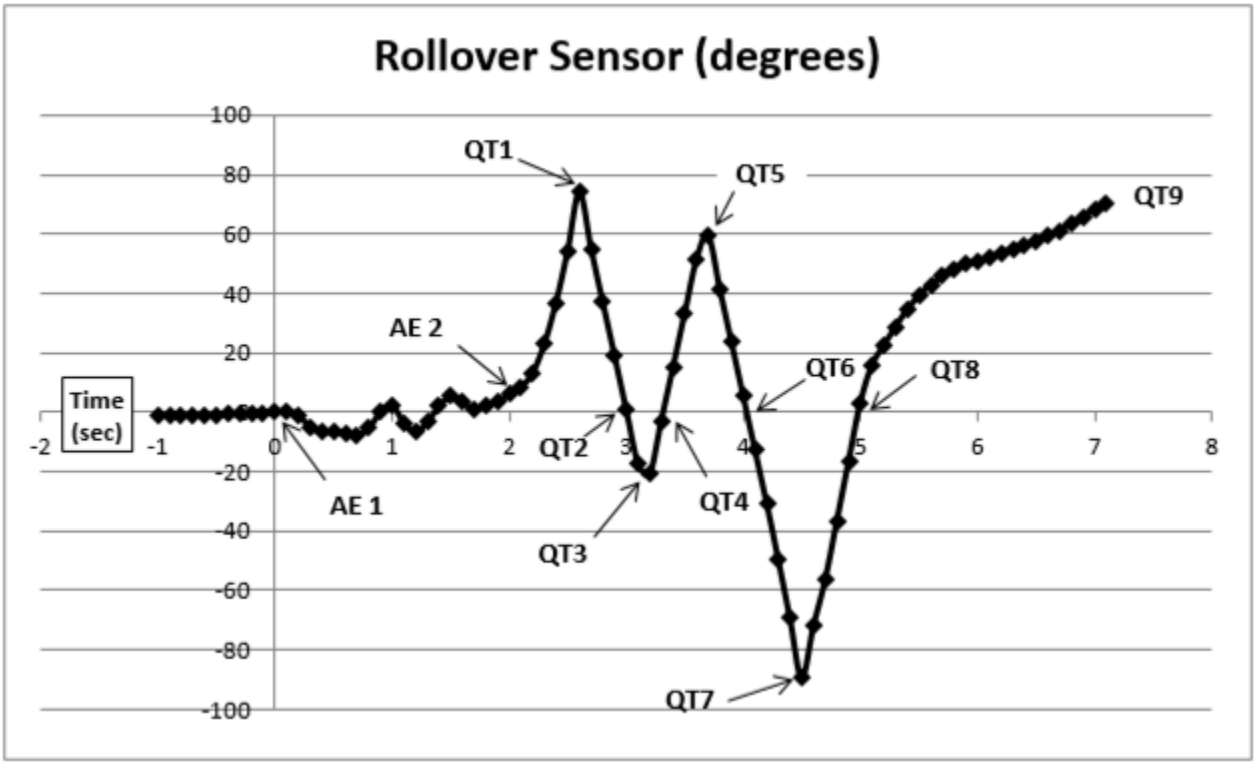
Time (seconds)	Speed km/h (mph)	Accelerator Pedal Percent Full	Brake Status	Engine rpm	Steering Wheel Angle (degrees)
-5	103 (64)	19.3	Off	2,038	-3.3
-4.5	103 (64)	19.3	Off	2,054	-2.7
-4	103 (64)	19.3	Off	2,062	-0.3
-3.5	105 (65)	19.3	Off	2,066	-0.5
-3	105 (65)	19.3	Off	2,064	-0.9
-2.5	105 (65)	16.1	Off	2,064	-0.8
-2	105 (65)	0	Off	2,068	-0.5
-1.5	105 (65)	0	Off	2,062	0.1
-1	105 (65)	0	Off	2,062	0.5
-0.9	---	---	---	---	0.4
-0.8	---	---	---	---	1.4
-0.7	---	---	---	---	1.9
-0.6	---	---	---	---	5.6
-0.5	103 (64)	0	Off	2,046	19
-0.4	---	---	---	---	24
-0.3	---	---	---	---	24.3
-0.2	---	---	---	---	29.4
-0.1	---	---	---	---	30.9
0 (AE)	103 (64)	0	Off	2,060	34.6

Second Record

The recording of data in this record was enabled by the closure of the rollover sensors and was attributed to the rollover - Event 2 of the SCI reconstruction. At the time of the recording the air bag warning lamp was on and there was one DTC. The DTC related to the occurrence of the Event 1 crash and a requirement to replace the RCM. The retractor pretensioners and IC air bags had already been commanded to deploy during the First Record. A field in the data set reported that a deployment had already occurred. This record commanded the actuation of the lower anchor pretensioners 281.5 milliseconds after AE.

The pre-crash data sets of the Second Record were consistent with the data recorded in the First Record (offset by the 2.1-second interval between the events). The Event 1 crash and the acceleration of the impact were recorded in the high-frequency stability control data. An integration-analysis of the Yaw Rate data calculated that the Ford had rotated approximately 250 degrees CW at the time of AE. This calculation was consistent with the reconstructed right side leading orientation of the vehicle at the commencement of the rollover.

The dynamics of the Ford's rollover were captured and recorded by rollover sensor. This data was consistent with the nine quarter turns of the SCI reconstruction. The recorded roll angle was centered on zero degrees and fluctuated over a range of plus and minus (+/-) 90 degrees. The chart below is a depiction of the combined rollover sensor data for the First and Second Records relative to the time history of the First Record. The total length of the combined data recording was 7.1 seconds. The timing of specific dynamics of the crash sequence (AE) and the quarter turns (QT) are highlighted in the chart below.



Interior Damage

The interior of the Ford sustained minor damage resulting from exterior deformation with intrusion of several components into the driver's position. The left upper A-pillar intruded 10 cm (4.0 in) vertically. This displacement buckled the windshield header upward at the midpoint and fractured the laminated windshield. The left roof side rail was displaced 9 m (3.5 in) laterally into the driver's space. There was no other intrusion of the occupant compartment.

The driver seat was adjusted to a mid-to-rear track position which measured 7 cm (2.8 in) forward of full rear (**Figure 12**). The total seat track travel measured 24 cm (9.5 in). The seatback was reclined 30 degrees aft of vertical. The horizontal distance from the seatback to the center hub of the steering wheel measured 55 cm (21.5 in). The front row right seat was adjusted 3 cm (1.0 in) forward of full rear with the seatback reclined 25 degrees (**Figure 13**). The horizontal distance from this seatback to the vertical face of the instrument panel measured 80 cm (31.3 in).

Figure 12: Left interior view of the Ford's driver seat.

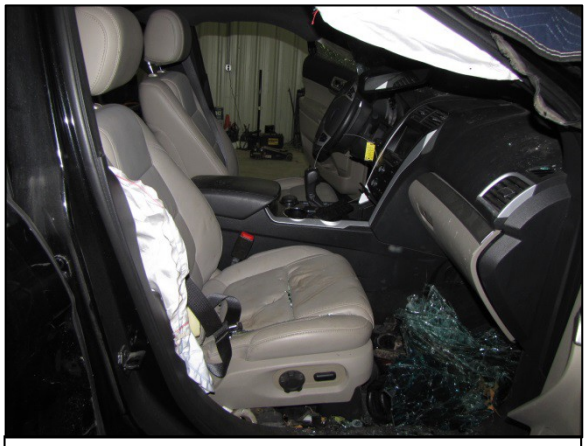


Figure 13: Right interior view of the Ford's front row right seat.

Due to the use of the manual seat belt systems, CRSs, and the deployment of the supplemental restraint systems (pretensioners and air bags), there was no occupant contact to the interior surfaces of the vehicle.

Manual Restraint Systems

The Ford was configured with continuous loop 3-point manual lap and shoulder seat belt systems for the seven seating positions. The driver and front row right seat belt systems utilized lightweight locking latch plates while the remaining second and third row seat positions used sliding latch plates. Both front row seat belt systems were equipped with retractor and lower anchor pretensioners that actuated during the crash. Adjustable D-rings were also present for the front row positions. The driver's seat was adjusted to the full-up position while the front row right was adjusted to a mid-position. The driver seat belt retracted onto an Emergency Locking Retractor (ELR) while the front row right was switchable from the ELR mode to an Automatic Locking Retractor (ALR) mode.

The driver used the seat belt system at the time of the crash. The actuation of the retractor pretensioner locked the webbing in the used position with 155 cm (61 in) of webbing extended from the B-pillar. Frictional loading abrasions were present on the lap belt portion of the webbing and on the shoulder belt at the location of the D-ring. The actuated floor-mounted lower anchor pretensioner was compressed to a height of 11 cm (4.5 in). The EDR also reported that the driver seat belt was buckled.

The front row right seat belt was in use at the time of the crash evidenced by the webbing that was in an extended position due to the actuation of the B-pillar-mounted retractor pretensioner. The extended length of the webbing measured 182 cm (71.5 in). Examination revealed that the webbing was creased at the D-ring with the surface abraded due to the frictional loading. The compressed height of the actuated lower anchor pretensioner measured 14 cm (5.5 in). The EDR also reported that this seat belt was buckled.

The second row seat belt systems retracted onto switchable ELR/ALR retractors. The left seat belt was used to secure the CRS in the vehicle. The seat belt webbing was routed through the forward-facing belt path of the CRS. At examination, this retractor was in the ELR mode, the installer of the CRS did not engage the ALR feature. A single vertical polymer loading transfer was present on the seat belt webbing. This transfer was in the belt path of the CRS and possibly occurred during the lateral movement of the CRS during the crash. The second row right occupant was restrained by the 3-point lap and shoulder belt system while she was seated in a backless booster CRS. The webbing of this salt belt was in the stowed position at inspection. Occupant loading of the seat belt was evidenced by a 6 cm (5.5 in) long crease that was located in the shoulder portion of the webbing 116-130 cm (45.8-51.3 in) above the lower anchor (**Figure 14**).

Figure 14: Interior view of the Ford's second row right seat and seat belt.

Supplemental Restraint Systems

The Ford was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual-stage air bags for the driver and front right occupant positions, front seat track positioning sensors, seat belt buckle switches, and retractor and lower anchor pretensioners. The driver's frontal air bag was concealed in the center hub of the 4-spoke steering wheel rim. The passenger's frontal air bag was mounted in the top aspect of the right instrument panel. The crash did not warrant deployment of the frontal air bags; however, the pretensioners did actuate. Supplemental side impact crash protection was provided by front seat-mounted air bags and dual-sensing IC air bags. The IC air bags were tested and certified to be compliant to FMVSS 226 to provide occupant protection and ejection mitigation in rollover crashes. The right seat-mounted and both IC air bags deployed during the Event 1 side impact crash.

The seat-mounted air bag deployed through the forward seam of the front row right seat back. The seam separated over a 51 cm (20.0 in) length. The air bag was oval in shape. In its deflated state the air bag measured 56 cm (22.0 in) tall and extended 13 cm (5.0 in) forward of the seat bolster. It was vented on the inboard (occupant) side by a 4 cm (1.3 in) diameter port. There was no damage or occupant contact evidence to the air bag.

The IC air bags deployed through a separation of the headliner from the roof side rails (**Figures 15 and 16**). The overall length of the IC air bags measured 251 cm (99.0 in), inclusive of a 23 cm (9.0 in) sail panel that filled the triangular void at the A-pillar areas. The IC air bags extended approximately 5 cm (2.0 in) below the level of the beltline in its deflated state. There was no residual evidence of occupant contact to the IC air bags.

Figure 15: Interior view of the Ford depicting the deployed air bags at the front row right position.

Figure 16: Interior view of the Ford depicting the deployed left IC air bag at the second row left posi-

Child Restraint Systems

The second row left occupant was restrained in a Doral Alpha Omega Elite CRS that was installed forward-facing. The CRS was manufactured on April 4, 2008, and was identified as Model No. 9B656688. The expiration date was April 2016. The CRS was designed for multi-purpose use, either rear-facing, forward-facing, or as a belt positioning booster seat. Placarding listed the heights and weights at 48 to 91 cm (19 to 36 in) and 2.3 to 16 kg (5 to 35 lb) for the rear-facing mode; 85.1 to 110 cm (34 to 43 in) and 10.1 to 18 kg (22 to 40 lb) for the forward-facing position; and 110.1 to 132.1 (43 to 52 in) and 18.1 to 45.4 kg (40 to 100 lb) for the belt positioning mode.

The CRS was constructed of a molded polymer shell with a Styrofoam liner in the area of the head and a cloth and leather outer cover. The integral harness system consisted of a 5-point harness. The shoulder straps were routed through an adjustable slide mechanism for vertical adjustment. It should be noted that the left harness strap was routed incorrectly over the slide bar on the back side of the CRS. At the time of the crash, the harness straps were adjusted to the top position. Comfort sleeves were sewn over the harness straps in the area of the child's chest. A chest clip was in place and positioned under the comfort sleeves. The harness straps were roped in the areas of the chest clip and the latch plates. The right hip strap was twisted. The CRS was manufactured with the LATCH system; however, the child's father did not use the LATCH system at the time of installation. The driver further stated during the SCI interview that she was unfamiliar with the certified child passenger safety technician (CPST) program and never attended a CRS checkpoint.

The CRS was installed with the vehicle 3-point lap and shoulder belt routed through the forward- facing belt path (**Figure 17**). The ALR mode of the retractor was not engaged; therefore the CRS was secured to the vehicle using the ELR mode of the switchable retractor. Post-crash, there was 8 cm (3 in) of lateral movement of the CRS at the belt path and 9 cm (3.5 in) of forward movement. The SCI inspection of the CRS determined that there was no damage to the CRS or loading evidence to the integral harness system. Additionally, there was no vehicle seat belt loading evidence at the belt path of the CRS.

Figure 17: Image of the CRS in the second row left position of the Ford.

The second row right occupant was seated on an unknown make/model low back belt positioning booster seat at the time of the crash. The CRS was discarded by the driver prior to the assignment of this investigation.

2015 FORD EXPLORER OCCUPANTS

Driver Demographics

Age/Sex:	35 years/female
Height:	173 cm (68 in)
Weight:	77 kg (170 lb)
Eyewear:	None
Seat Type:	Bucket seat
Seat Track Position:	Mid-to-rear track
Manual Restraint Usage:	3-point lap and shoulder seat belt
Usage Source:	SCI vehicle inspection, EDR
Air Bags:	Front, seat-mounted side impact and dual sensing IC air bags available; left IC air bag deployed
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Assisted through windshield opening
Transport From Scene:	None
Medical Treatment:	None

Driver Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Not injured	N/A	N/A	N/A

Source: Driver Interview

Driver Kinematics

The driver of the Ford was seated in an upright posture with the seat track adjusted to a mid-to-rear track position. The seatback was slightly reclined and the head restraint was adjusted 5 cm (2 in) above the seatback. She was wearing the manual 3-point lap and shoulder seat belt with the lap belt snug across her hips and the shoulder belt webbing across her left shoulder. The D-ring was adjusted to the full-up position. Immediately prior to the crash, the driver steered left as she detected the Oldsmobile enter the intersection.

At impact, the IC air bags deployed and the seat belt retractor pretensioners actuated. The driver responded to the right plane impact by moving laterally to her right and forward. Her pelvic region loaded the lap belt webbing as her torso engaged the shoulder belt webbing. Although she was not injured as a result of the seat belt loading, the driver loading of the belt system was evidenced by frictional abrasions at the D-ring and latch plate locations of the webbing. The driver's right hip and lateral right thigh possibly contacted the center console during the lateral component of her trajectory; although no injury or contact evidence was noted.

The Event 1 impact rotated the Ford in a CW direction for a total of approximately 245 degrees as the Ford departed the north shoulder and roadside. The vehicle overturned into a right plane leading lateral rollover event (Event 2). The driver again loaded the seat belt webbing and possibly the deployed IC air bag which prevented her from contact with the left side glazing and interior hard surfaces.

The Ford came to rest on its right plane. Passers-by stopped at the crash site and tore open the fractured windshield laminate in order to assist the driver from the vehicle through the windshield opening. She was not injured and refused medical treatment at the scene. She did not pursue follow-up treatment.

Front Row Right Occupant Demographics

Age/Sex:	70 years/female
Height:	165 cm (65 in)
Weight:	95 kg (210 lb)
Eyewear:	Unknown
Seat Type:	Bucket seat
Seat Track Position:	Rear
Manual Restraint Usage:	3-point lap and shoulder seat belt system
Usage Source:	SCI vehicle inspection, EDR
Air Bags:	Frontal, seat-mounted side impact and dual sensing IC air bags available; seat-mounted and right IC air bags deployed
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Assisted through windshield opening
Transport From Scene:	None
Medical Treatment:	None

Front Row Right Occupant Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	None	N/A	N/A	N/A

Source: Driver Interview

Front Row Right Occupant Kinematics

The front row right occupant was seated in an upright posture with the seat track adjusted to a rear track position with the seatback slightly reclined. The head restraint was adjusted (3.5 in) above the seatback. This occupant was wearing the manual seat belt system with the D-ring adjusted to a mid-position.

At impact with the Oldsmobile (Event 1), the front row right occupant initiated a lateral and slightly forward trajectory. She loaded the seat belt system and the deployed seat-mounted and right IC air bags. The combination of seat belt used and air bag deployment restrained the occupant in her seat position and protected her from contact with the right door panel and hard roof support surfaces.

As the Ford rotated CW, the occupant's trajectory translated to the left and her left hip possibly contacted the center console. There was no injury or contact evidence to support this contact. The Ford overturned into a right side leading rollover. The occupant loaded the seat belt system and the deployed IC air bag and rode down the force of the crash. After completing nine-quarter turns, the Ford came to rest on its right plane. Passers-by stopped at the crash site and pulled the fractured windshield away from the mount and assisted the front row right occupant from the vehicle. She denied injury and refused medical treatment.

Second Row Left Occupant Demographics

Age/Sex:	2 years/female
Height:	86 cm (34 in)
Weight:	16 kg (35 lb)
Eyewear:	None
Seat Type:	Split-back bench seat
Seat Track Position:	Fixed
Manual Restraint Usage:	Used to secure a CRS
Usage Source:	SCI vehicle inspection, driver interview
Air Bags:	Dual sensing IC air bags available; IC air bags deployed.
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Assisted through the lift gate opening of the Ford
Transport From Scene:	None
Medical Treatment:	None

Second Row Left Occupant Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	None	N/A	N/A	N/A

Source: Driver Interview

Second Row Left Occupant Kinematics

The second row left child occupant was restrained in a forward-facing CRS by the 5-point integrated harness. The CRS was installed in the full-upright position and was secured to the Ford by the vehicle's manual 3-point lap and shoulder belt that was routed through the forward-facing belt path. Although the CRS was equipped with LATCH, this system was not in use at the time of the crash.

In response to the initial right plane impact event, the child was displaced to her right and remained in the confines of the CRS, restrained by the harness system and protected by the side shielding of the CRS shell. As the vehicle rotated clockwise and subsequently overturned, the occupant loaded the harness system and the shell of the CRS. The CRS was effective in holding the child occupant in position and preventing her from injury.

Post-crash, she was assisted from the CRS by the second row right occupant and with the help of passers-by was removed through the lift gate opening of the Ford. She was examined at the scene for possible injury. Since none were found, the driver refused medical transport and did not seek follow-up treatment.

Second Row Right Occupant Demographics

Age/Sex:	5 years/female
Height:	109 cm (43 in)
Weight:	19 kg (42 lb)
Eyewear:	None
Seat Type:	Split-back bench seat
Seat Track Position:	Fixed
Manual Restraint Usage:	Restrained in a low back booster CRS
Usage Source:	SCI vehicle inspection, driver interview
Air Bags:	Dual sensing IC air bags available; the IC air bags deployed.
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Assisted through the lift gate opening of the Ford
Transport From Scene:	None
Medical Treatment:	None

Second Row Right Occupant Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Contusion of the right anterior neck	310402.1	Shoulder belt webbing	Certain
2	Contusion of the right upper chest	410402.1	Shoulder belt webbing	Certain

Source: Driver Interview

Second Row Right Occupant Kinematics

The second row right child occupant was seated in a backless booster CRS and restrained by the vehicle's manual 3-point lap and shoulder seat belt system. Based on injury data, the child occupant had the shoulder belt positioned over her right shoulder.

She responded to the Event 1 crash by moving laterally right and forward. This trajectory allowed her to load the seat belt system. Additionally, the right IC air bag deployed during the Event 1 impact. The deployment of the IC air bag provided protection from contact against the right rear door glazing and the right roof side rail. There was no contact evidence to the deployed IC air bag. During the rollover event (Event 2), the second row right child occupant again loaded the seat belt webbing and possibly the inflated IC air bag. The combination of the safety systems held her in position and prevented her from contact with interior components. She sustained soft tissue contusions of the right upper chest and right lateral neck from loading the seat belt webbing during the crash sequence.

Post-crash, she was assisted from the vehicle by a passer-by through the rear lift gate. Her mother and EMS personnel examined her for possible injury at the scene. Additional medical treatment was refused.

2002 OLDSMOBILE BRAVADA

Description

The other vehicle in this crash was a 2002 Oldsmobile Bravada, four-door SUV (**Figure 18**). The Oldsmobile was not registered and was being operated by a driver who fled the scene after the crash. At the time of the case assignment, the Oldsmobile had been released from the tow yard and could not be located for inspection. Based on specifications for this vehicle, the Oldsmobile was powered by a 4.2-liter V-6 gasoline engine linked to a 4-speed automatic transmission with all-wheel drive.

Figure 18: Image of the Oldsmobile taken during its recovery by police. Image obtained from an Internet news source.

The seating configuration was for five occupants with front row bucket seats and a forward folding second row bench seat. Safety systems included 3-point manual lap and shoulder belts and dual- stage frontal air bags for the driver and front row right positions.

Exterior Damage

Two images obtained from Internet news sources depicted the exterior damage to the Oldsmobile. The vehicle sustained impact deformation that was distributed across the frontal plane (**Figure 19**). The heaviest concentration of damage was located at the front left corner with separation of the bumper fascia, crush of the bumper reinforcement, and contact damage to the leading edge of the left front fender and hood face. The maximum crush was an estimated 25 cm (10.0 in) located at the left aspect of the front bumper. The direct contact damage extended across the entire width of the vehicle. The grille, air conditioning condenser, and upper radiator support appeared to have been sustained impact and damage. All glazing was intact and all four doors appeared to have remained closed and operational post-crash. The CDC for this Event 1 damage pattern was 11FDEW1.

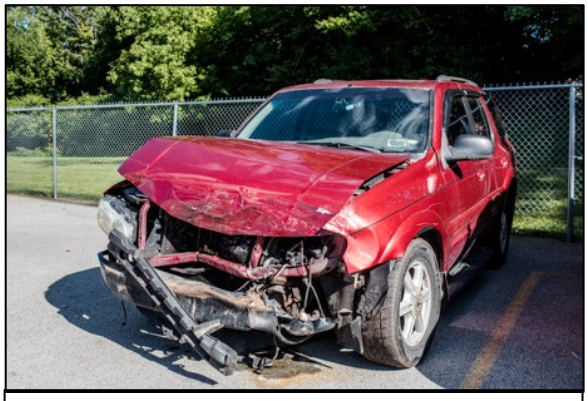
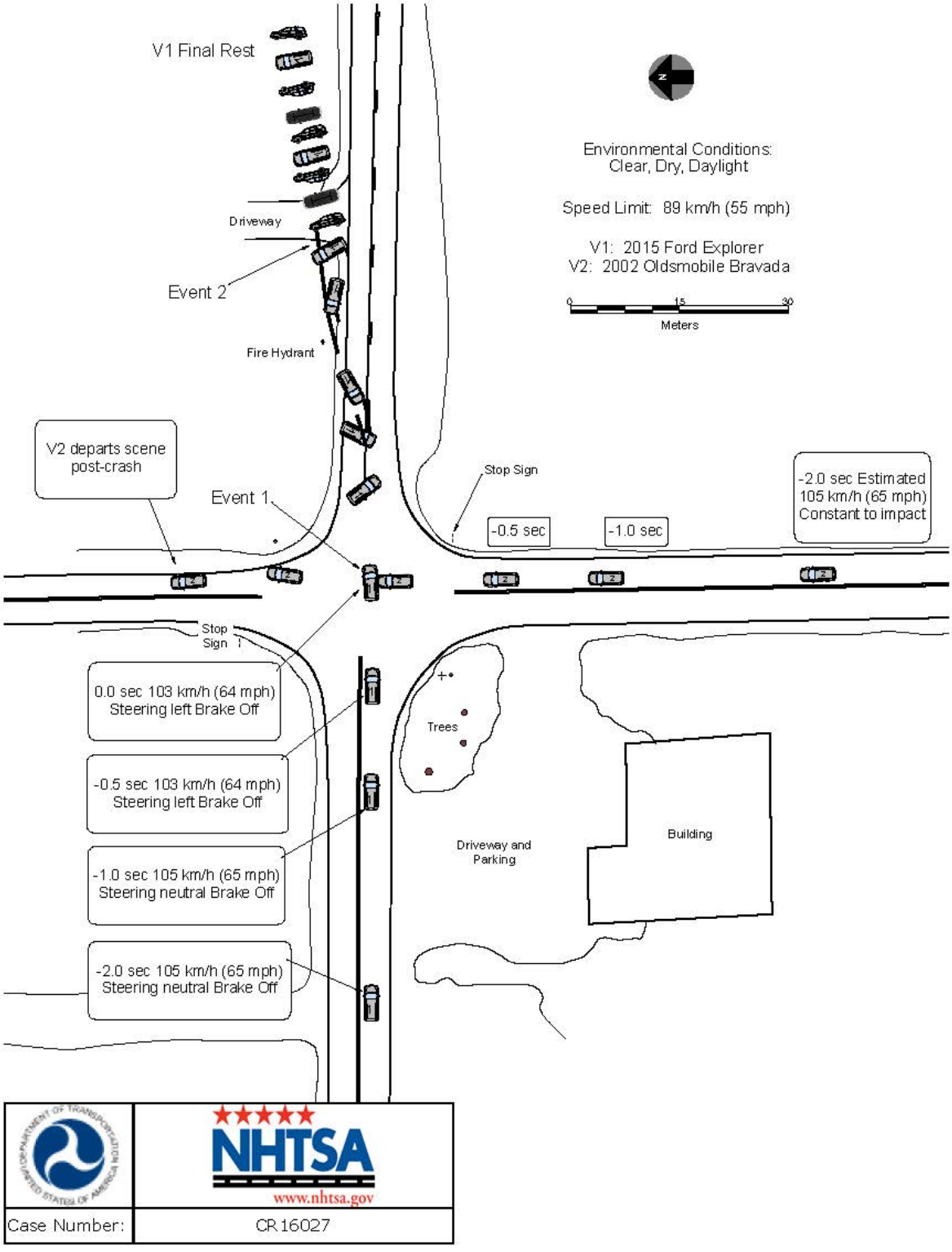


Figure 19: Front view of the Oldsmobile after recovery by the police. Image supplied by an Internet news source.

Occupant Data

The 2002 Oldsmobile Bravada was occupied by at least the driver, who fled the crash scene in the damaged vehicle after the crash occurred. The police later determined that the driver was a 46- year-old male. Police documentation of the crash indicated that he was not injured.

CRASH DIAGRAM



APPENDIX A:

2015 Ford Explorer Event Data Recorder (EDR) Report[1]

[1] The Event Data Recorder (EDR) report published as part of this technical report and the CDR report contained within the associated Crash Viewer application may differ. The CDRx file is provided in the Crash Viewer and reader can run the CDRx file with the latest software version of the Bosch CDR tool reader (https://www.boschdiagnostics.com/cdr/software-downloads)

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	1FM5K8D85FG******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CR16027_V1_ACM.CDRX
Saved on	Wednesday, October 19 2016 at 14:15:40
Imaged with CDR version	Crash Data Retrieval Tool 17.0
Imaged with Software Licensed to (Company Name)	NHTSA
Reported with CDR version	Crash Data Retrieval Tool 17.7.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
ACM Adapter Detected During Download	No
Event(s) recovered	locked side event locked rollover event

Comments

No comments entered.

Data Limitations

Data Imaging:

CAUTION: When imaging data directly from the RCM on a bench top, make sure the RCM is placed on a flat surface without any movement (static) while connected to and powered by the CDR interface. Not following the above guideline for bench top imaging could risk inducing new events to be recorded in the RCM and possibly overwriting a Non airbag deployment.

Note that the RCM Adapter Detected during Download parameter equal to " Yes" indicates that the EDR data was collected directly from the RCM. When equal to "No", it indicates that the EDR data was collected through the OBD II from the vehicle.

Restraints Control Module (RCM) Recorded Crash Event(s):

The RCM can store up to two crash events. Event types are categorized as follow:

1. Non deployment trigger event is an event in which EDR recording trigger threshold is met or exceeded (minimum of 5 mph (8kph) Accumulated Delta Velocity within 150ms interval), but no device(s) have deployed. The data from such event can be overwritten by subsequent events.

2. Airbag deployment event is an event in which frontal, side or curtain airbags have deployed. Note that such event cannot be overwritten or cleared from the Restraints Control Module (RCM). Once the RCM has deployed any airbag device(s), the RCM must be replaced.

3. Some RCM may also categorize Non airbag deployment event. This type is an event in which non airbag devices such as pretentioners, knee bolster etc… have deployed. Note that such event can be overwritten given a subsequent "deployment" event.

"Time zero" or Event Beginning of any event (First Record or Second Record) is defined as the first Algorithm wake up during that event. So all the Pre-Crash, At Event, Delta V Data, deployment times etc… are relative to "Time zero".

It is possible that conditions in a crash may result in an incomplete event data record.

EDR Data Elements Overview/Interpretation in CDR Report:

Under CDR File Information Section

- Event(s) recovered indicates if an event was detected and recorded by RCM. If no event is detected, it will indicate "none". If a trigger or non airbag deployment event is detected, it will indicate "unlocked event". If an airbag deployment is detected, it will indicate "locked frontal event", or "locked side event", or "locked rollover event".

Under System Status at Event Section

- Complete file recorded indicates if data from the recorded event has been fully written to the RCM memory.
- If the RCM detected a peripheral crash sensor was lost during an event, the crash sensor would be identified as well as the time it was lost during that event relative to Time zero. If no loss of a peripheral crash sensor, nothing would be displayed. Note in some vehicles, loss of a peripheral crash sensor may lead to the loss of another peripheral crash sensor due to shared communication.

Under Deployment Data Section

- If the RCM commanded a deployment during an event, the deployment device(s) would be identified as well as the time the RCM commanded its deployment relative to Time zero. If no device was commanded to deploy by the RCM, nothing (no deployment device(s)) would be displayed.

Under Pre-Crash Data -5 to 0 sec

- Steering Wheel Angle if Applicable: positive value indicates left turn, and negative value would indicate right turn.
- Stability Control Lateral Acceleration if Applicable: Lateral Acceleration (Y-direction) is the acceleration along the lateral axis of the vehicle, reported as positive when accelerating to the left.
- Stability Control Longitudinal Acceleration if Applicable**:** Longitudinal Acceleration (X-direction) is the acceleration along the longitudinal axis of the vehicle, reported as positive when accelerating in a forward direction.
- Stability Control Yaw Rate if Applicable: The Yaw Axis is the vertical axis of the vehicle, generally perpendicular to the plane of the road. A positive Yaw Rate is counter-clockwise when observing the vehicle from above.
- Stability Control Roll Rate if Applicable: The Roll Axis is the longitudinal axis of the vehicle, generally aligned with the primary axis of motion of the vehicle. A positive Roll Rate is counter-clockwise when observing the vehicle from the front.

Under Longitudinal Crash Pulse

- Delta-V, longitudinal: SAE J211 sign convention, negative value generally indicates a front crash and positive value generally indicates a rear crash. Longitudinal delta-V reflects the change in forward velocity that the sensing system experienced from Time zero. It is not the speed the vehicle was traveling before the event. Note that the vehicle speed is recorded separately. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle longitudinal delta-V.

Under Lateral Crash Pulse

- Delta-V, lateral: SAE J211 sign convention, Positive value generally indicates a driver side crash and negative value generally indicates a passenger side crash.

Under Rollover Sensor Data (if Applicable)

- Vehicle roll angle if applicable: The Roll Axis is the longitudinal axis of the vehicle, generally aligned with the primary axis of motion of the vehicle. A positive Roll Angle is counter-clockwise when observing the vehicle from the front.

Data Sources:

The Restraints Control Module (RCM) contains all recorded data on any event. Data collected from the RCM comes from multiple sources:

1. Internal to the RCM such as internal sensors for delta Velocity data, rollover angle data if applicable, etc… which are measured, calculated and stored internally.

2. External to the RCM but with a direct connection such as buckle switches, peripheral crash sensors, seat track switch(s) etc… which are measured, calculated and stored internally.

3. External Modules to the RCM such as Powertrain Control Module, Brake Control Module, etc… Theses modules communicate to the RCM via Vehicle Communication Network. The RCM stores the received data internally.

System Status at Time of Retrieval

VIN As Programmed into RCM at Factory	1FM5K8D85FG******
Current VIN from PCM	1FM5K8D85FG******
Ignition Cycle, Download (First Record)	2,922
Ignition Cycle, Download (Second Record)	2,922
Restraints Control Module Part Number	EB5T-14B321-AA
Restraints Control Module Serial Number	7164114300000000
Restraints Control Module Software Part Number (Version)	DG13-14C028-AG
Driver Side/Center Frontal Restraints Sensor Serial Number	00A11826
Driver, Row 1, Side Restraint Sensor 1 Serial Number	00000000
Driver, Row 2, Side Restraint Sensor 2 Serial Number	00BB17FD
Passenger Frontal Restraints Sensor Serial Number	00A3177A
Passenger, Row 1, Side Restraint Sensor 1 Serial Number	0000000E
Passenger, Row 2, Side Restraint Sensor 2 Serial Number	009B1826

System Status at Event (First Record)

Recording Status	Record Locked
Complete File Recorded (Yes, No)	Yes
Multi-Event, Number of Events	1
Time From Event 1 to 2 (msec)	N/A
Lifetime Operating Timer at Event Time Zero (sec)	4,500,855
Key-On Timer at Event Time Zero (sec)	190
Vehicle Voltage at Time Zero (V)	14.418
Energy Reserve Mode Entered During Event (Yes, No)	No

Faults Present at Start of Event (First Record)

No Faults Recorded

Deployment Data (First Record)

Side Curtain Airbag Deployment, Time to Deploy, Driver Side (msec)	49.0
Pretensioner (Retractor) Deployment, Time to Fire, Driver (msec)	49.0
Side Curtain Airbag Deployment, Time to Deploy, Passenger Right Side (msec)	49.0
Side (Thorax) Airbag Deployment, Time to Deploy, Right Front Passenger (msec)	49.0
Pretensioner (Retractor) Deployment, Time to Fire, Right Front Passenger (msec)	49.0
Maximum Delta-V, Longitudinal (MPH [km/h])	-6.17 [-9.93]
Time, Maximum Delta-V Longitudinal (msec)	300
Maximum Delta-V, Lateral (MPH [km/h])	-6.65 [-10.70]
Time, Maximum Delta-V Lateral (msec)	90
Driver Row 2, Side Sensor, Safing	Yes
Passenger Row 1, Side Sensor, Safing	Yes
Passenger Row 2, Side Sensor, Discriminating Deployment	Yes
Passenger Row 2, Side Sensor, Safing	Yes
RCM, Side Driver (Lateral), Safing	Yes
RCM Side Passenger (Lateral), Safing	Yes
Longitudinal Delta-V Time Zero Offset (msec)	5.0 ms
Lateral Delta-V Time Zero Offset (msec)	5.0 ms
Roll Angle Time Zero Offset (msec)	35.0 ms

Pre-Crash Data -1 sec (First Record)

Ignition Cycle, Crash	2,919
Frontal Air Bag Warning Lamp, On/Off	Off
Safety Belt Status, Driver	Buckled
Seat Track Position Switch, Foremost, Status, Driver	Not Forward
Safety Belt Status, Front Passenger	Buckled
Seat Track Position Switch, Foremost, Status, Front Passenger	Not Forward
Brake Telltale	Off
ABS Telltale	Off
ESC/TC Telltale	Off
ESC/TC Off Telltale	Default
Powertrain Wrench Telltale	Off
Powertrain Malfunction Indicator Lamp (MIL) Telltale	Off

Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record, table 1 of 2)

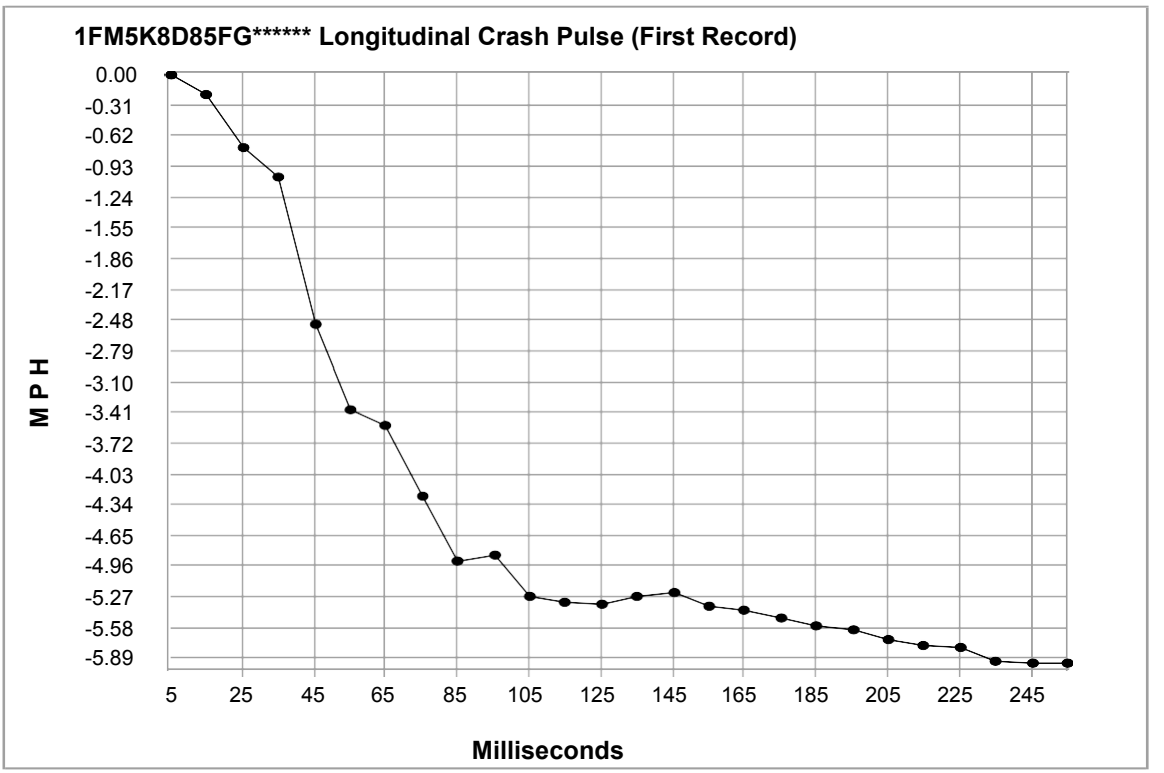
Times (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal, % Full	Service Brake, On/Off	Engine RPM	ABS Activity (Engaged, Non-Engaged)	Brake Powertrain Torque Request
- 5.0	64 [103]	19.3	Off	2,038	non-engaged	No
- 4.5	64 [103]	19.3	Off	2,054	non-engaged	No
- 4.0	64 [103]	19.3	Off	2,062	non-engaged	No
- 3.5	65 [104]	19.3	Off	2,066	non-engaged	No
- 3.0	65 [104]	19.3	Off	2,064	non-engaged	No
- 2.5	65 [104]	16.1	Off	2,064	non-engaged	No
- 2.0	65 [104]	0.0	Off	2,068	non-engaged	No
- 1.5	65 [104]	0.0	Off	2,062	non-engaged	No
- 1.0	65 [104]	0.0	Off	2,062	non-engaged	No
- 0.5	64 [103]	0.0	Off	2,046	non-engaged	No
0.0	64 [103]	0.0	Off	2,060	non-engaged	No

Pre-Crash Data -5 to 0 sec [2 samples/sec] (First Record, table 2 of 2)

Times (sec)	Driver Gear Selection	Traction Control via Brakes	Wheel Torque (Nm)	Occupant Size Classification, Front Passenger (Child Size Yes/No [Hex value])	Speed Control Telltale
- 5.0	Drive	non-engaged	376	No [$08]	Off
- 4.5	Drive	non-engaged	380	No [$08]	Off
- 4.0	Drive	non-engaged	376	No [$08]	Off
- 3.5	Drive	non-engaged	380	No [$08]	Off
- 3.0	Drive	non-engaged	372	No [$08]	Off
- 2.5	Drive	non-engaged	300	No [$08]	Off
- 2.0	Drive	non-engaged	268	No [$08]	Off
- 1.5	Drive	non-engaged	-28	No [$08]	Off
- 1.0	Drive	non-engaged	-76	No [$08]	Off
- 0.5	Drive	non-engaged	-108	No [$08]	Off
0.0	Drive	non-engaged	-160	No [$08]	Off

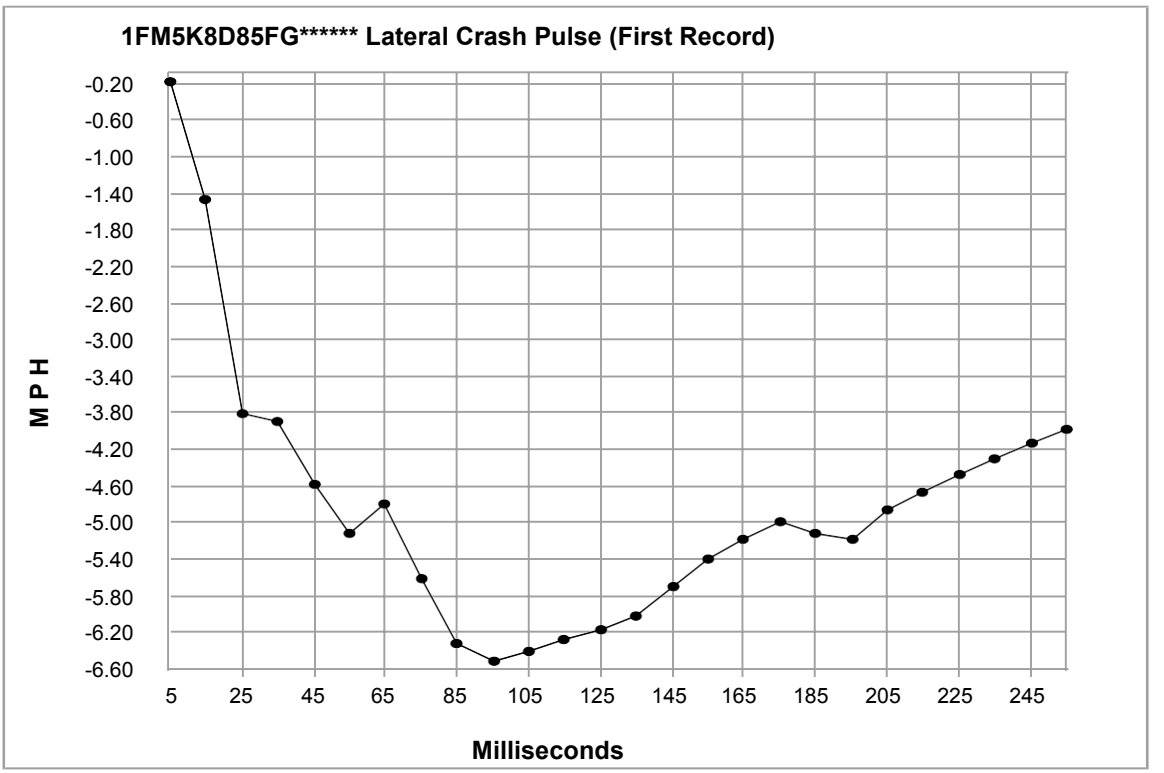
Pre-Crash Data -5 to 0 sec [10 samples/sec] (First Record)

Times (sec)	Steering Wheel Angle (degrees)	Stability Control Lateral Acceleration (g)	Stability Control Longitudinal Acceleration (g)	Stability Control Yaw Rate (deg/sec)	Stability Control Roll Rate (deg/sec)
- 5.0	-3.3	-0.042	-0.006	0.18	0.16
- 4.9	-3.0	-0.054	0.011	-0.02	0.16
- 4.8	-3.0	-0.039	-0.014	-0.22	-0.8
- 4.7	-3.0	-0.01	0.008	-0.25	-1.92
- 4.6	-2.8	-0.057	-0.016	-0.31	0.0
- 4.5	-2.7	-0.071	0.0	-0.09	0.84
- 4.4	-2.5	-0.072	-0.001	-0.13	0.76
- 4.3	-1.8	-0.031	0.005	-0.04	0.2
- 4.2	-1.6	-0.057	-0.004	-0.02	-0.92
- 4.1	-1.0	-0.028	-0.001	0.13	-0.68
- 4.0	-0.3	-0.033	0.0	0.2	0.0
- 3.9	-0.5	-0.001	-0.005	0.59	0.84
- 3.8	-0.5	-0.025	0.019	0.7	-0.24
- 3.7	-0.5	-0.009	-0.001	0.52	-0.08
- 3.6	-0.5	-0.01	0.009	0.4	0.04
- 3.5	-0.5	-0.025	-0.023	0.47	1.2
- 3.4	-0.5	0.012	0.013	0.7	-1.28
- 3.3	-0.5	0.006	-0.015	0.36	-1.4
- 3.2	-0.6	-0.011	0.011	0.29	-1.04
- 3.1	-0.6	-0.042	0.001	0.13	0.36
- 3.0	-0.9	-0.065	0.003	0.31	0.32
- 2.9	-1.0	-0.046	-0.014	0.31	-0.12
- 2.8	-0.8	-0.018	-0.019	0.22	-0.08
- 2.7	-0.7	-0.002	0.006	0.2	-0.84
- 2.6	-0.6	-0.01	-0.024	0.27	0.8
- 2.5	-0.8	-0.012	0.004	0.38	-0.64
- 2.4	-1.0	0.006	-0.021	0.27	-0.04
- 2.3	-0.8	-0.037	-0.012	0.11	0.92
- 2.2	-1.0	-0.058	-0.042	0.15	-0.56
- 2.1	-0.8	-0.011	-0.043	0.04	-1.16
- 2.0	-0.5	-0.022	-0.052	0.11	0.24
- 1.9	-0.6	-0.03	-0.036	0.4	0.72
- 1.8	-0.6	-0.079	-0.039	0.34	1.08
- 1.7	-0.5	-0.033	-0.071	0.2	1.56
- 1.6	-0.5	-0.025	-0.039	0.13	-1.4
- 1.5	0.1	-0.033	-0.06	0.02	-2.72
- 1.4	1.4	-0.002	-0.04	0.11	-0.52
- 1.3	0.6	-0.027	-0.058	0.7	-1.0
- 1.2	0.3	-0.006	-0.04	0.72	-1.2
- 1.1	0.4	0.001	-0.058	0.52	0.28
- 1.0	0.5	-0.006	-0.058	0.61	-0.48
- 0.9	0.4	-0.018	-0.084	0.61	-0.4
- 0.8	1.4	-0.004	-0.027	0.56	-0.2
- 0.7	1.9	-0.028	-0.076	0.7	0.52
- 0.6	5.6	0.047	-0.052	1.13	-0.04
- 0.5	19.0	0.176	-0.059	3.29	1.64
- 0.4	24.0	0.217	-0.053	6.79	2.36
- 0.3	24.3	0.273	-0.271	8.59	1.32
- 0.2	29.4	0.367	-0.249	9.34	2.52
- 0.1	30.9	0.425	-0.196	10.4	2.52
0.0	34.6	0.485	-0.084	11.15	2.56



Longitudinal Crash Pulse (First Record)

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
5.0	-0.02	-0.04
15.0	-0.22	-0.36
25.0	-0.74	-1.20
35.0	-1.06	-1.70
45.0	-2.54	-4.09
55.0	-3.39	-5.46
65.0	-3.54	-5.69
75.0	-4.25	-6.84
85.0	-4.91	-7.90
95.0	-4.84	-7.79
105.0	-5.27	-8.49
115.0	-5.34	-8.59
125.0	-5.34	-8.60
135.0	-5.26	-8.46
145.0	-5.24	-8.43
155.0	-5.37	-8.64
165.0	-5.41	-8.71
175.0	-5.49	-8.84
185.0	-5.56	-8.94
195.0	-5.61	-9.03
205.0	-5.70	-9.18
215.0	-5.75	-9.26
225.0	-5.78	-9.29
235.0	-5.91	-9.52
245.0	-5.95	-9.57
255.0	-5.95	-9.57



Lateral Crash Pulse (First Record)

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
5.0	-0.18	-0.29
15.0	-1.46	-2.35
25.0	-3.81	-6.12
35.0	-3.90	-6.27
45.0	-4.59	-7.39
55.0	-5.12	-8.25
65.0	-4.79	-7.71
75.0	-5.62	-9.04
85.0	-6.31	-10.16
95.0	-6.51	-10.47
105.0	-6.41	-10.32
115.0	-6.29	-10.12
125.0	-6.16	-9.92
135.0	-6.02	-9.70
145.0	-5.71	-9.19
155.0	-5.40	-8.69
165.0	-5.18	-8.33
175.0	-4.99	-8.04
185.0	-5.11	-8.23
195.0	-5.19	-8.35
205.0	-4.87	-7.83
215.0	-4.67	-7.52
225.0	-4.48	-7.22
235.0	-4.31	-6.93
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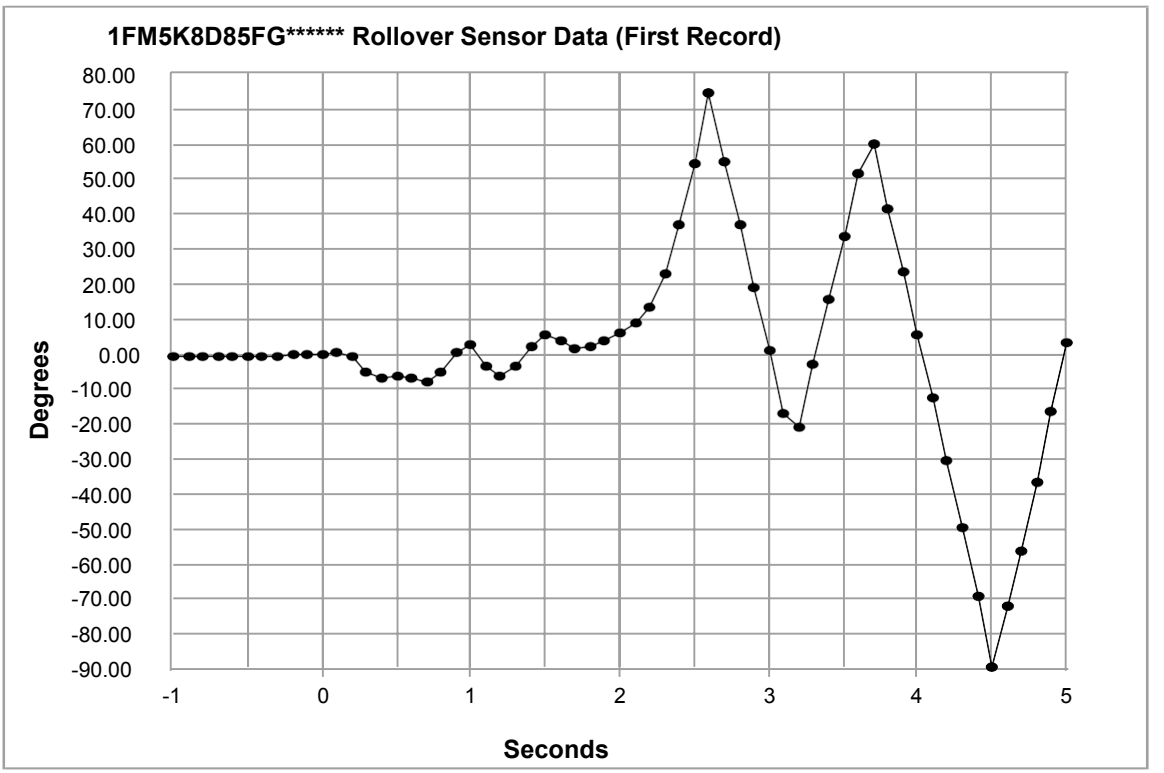
255.0	-3.97	-6.40



Rollover Sensor Data (First Record)

Time (sec)	Vehicle Roll Angle (deg)
-1.0	-0.96
-0.9	-0.96
-0.8	-0.96
-0.7	-0.95
-0.6	-0.94
-0.5	-0.92
-0.4	-0.7
-0.3	-0.56
-0.2	-0.39
-0.1	-0.13
0.0	-0.04
0.1	0.52
0.2	-1.05
0.3	-5.02
0.4	-6.74
0.5	-6.55
0.6	-7.04
0.7	-7.9
0.8	-5.39
0.9	0.12
1.0	2.32

Time (sec)	Vehicle Roll Angle (deg)
1.1	-3.65
1.2	-6.61
1.3	-3.35
1.4	2.08
1.5	5.32
1.6	3.43
1.7	1.24
1.8	2.23
1.9	3.52
2.0	6.14
2.1	8.48
2.2	13.23
2.3	22.99
2.4	36.89
2.5	54.34
2.6	74.14
2.7	55.0
2.8	37.0
2.9	18.99
3.0	0.98
3.1	-17.05

Time (sec)	Vehicle Roll Angle (deg)
3.2	-20.78
3.3	-2.78
3.4	15.23
3.5	33.24
3.6	51.24
3.7	59.55
3.8	41.54
3.9	23.53
4.0	5.53
4.1	-12.48
4.2	-30.49
4.3	-49.39
4.4	-69.3
4.5	-89.39
4.6	-72.02
4.7	-56.52
4.8	-36.68
4.9	-16.7
5.0	3.04

System Status at Event (Second Record)

Recording Status	Record Unlocked Deployed
Complete File Recorded (Yes, No)	Yes
Multi-Event, Number of Events	2
Time From Event 1 to 2 (msec)	2,100
Lifetime Operating Timer at Event Time Zero (sec)	4,500,855
Key-On Timer at Event Time Zero (sec)	190
Vehicle Voltage at Time Zero (V)	13.041
Energy Reserve Mode Entered During Event (Yes, No)	No

Faults Present at Start of Event (Second Record)

B1193-00

Deployment Data (Second Record)

Pretensioner (Anchor) Deployment, Time to Fire, Driver (msec)	281.5
Pretensioner (Anchor) Deployment, Time to Fire, Right Front Passenger (msec)	281.5
Maximum Delta-V, Longitudinal (MPH [km/h])	0.78 [1.25]
Time, Maximum Delta-V Longitudinal (msec)	290
Maximum Delta-V, Lateral (MPH [km/h])	-13.82 [-22.24]
Time, Maximum Delta-V Lateral (msec)	294
RCM, Rollover, Discriminating Deployment	Yes
RCM, Vertical, Safing	Yes
Longitudinal Delta-V Time Zero Offset (msec)	5.5 ms
Lateral Delta-V Time Zero Offset (msec)	5.5 ms
Roll Angle Time Zero Offset (msec)	95.5 ms

Pre-Crash Data -1 sec (Second Record)

Ignition Cycle, Crash	2,919
Frontal Air Bag Warning Lamp, On/Off	On
Safety Belt Status, Driver	Buckled
Seat Track Position Switch, Foremost, Status, Driver	Not Forward
Safety Belt Status, Front Passenger	Buckled
Seat Track Position Switch, Foremost, Status, Front Passenger	Not Forward
Brake Telltale	Off
ABS Telltale	Off
ESC/TC Telltale	On
ESC/TC Off Telltale	Mode 1
Powertrain Wrench Telltale	Off
Powertrain Malfunction Indicator Lamp (MIL) Telltale	Off

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Second Record, table 1 of 2)

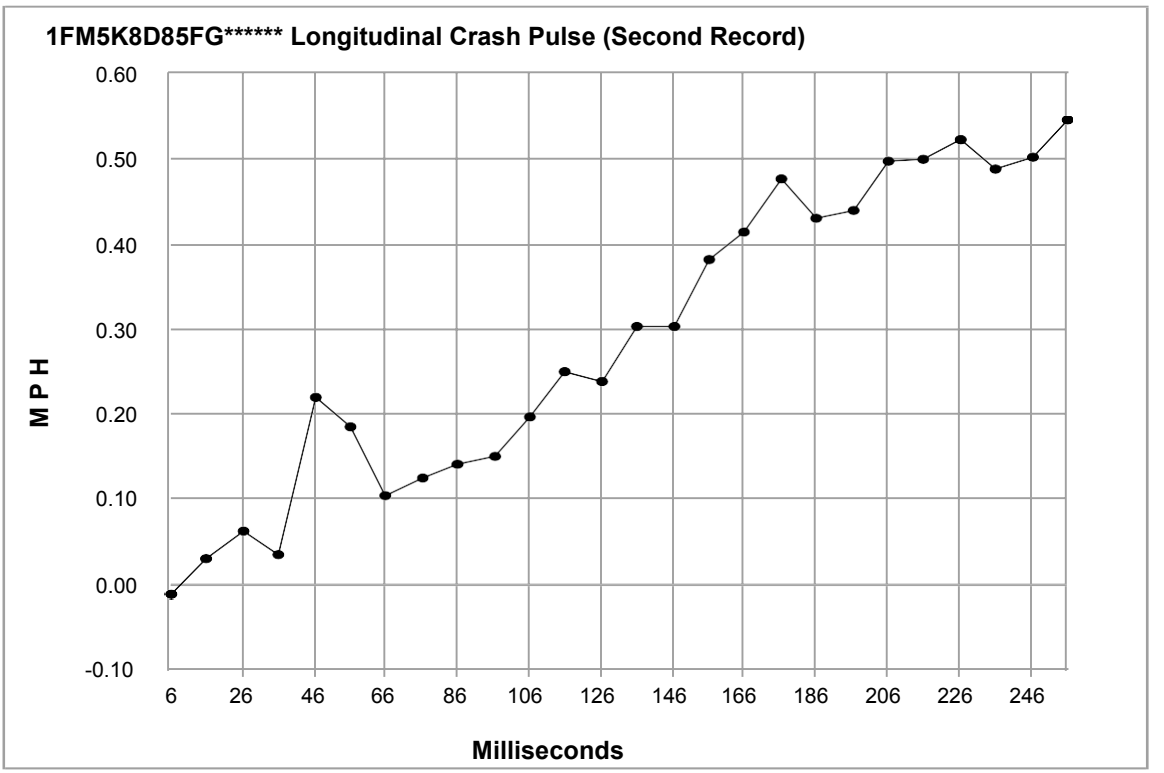
Times (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal, % Full	Service Brake, On/Off	Engine RPM	ABS Activity (Engaged, Non-Engaged)	Brake Powertrain Torque Request
- 5.0	65 [104]	16.1	Off	2,064	non-engaged	No
- 4.5	65 [104]	0.0	Off	2,068	non-engaged	No
- 4.0	65 [104]	0.0	Off	2,062	non-engaged	No
- 3.5	65 [104]	0.0	Off	2,062	non-engaged	No
- 3.0	64 [103]	0.0	Off	2,046	non-engaged	No
- 2.5	64 [103]	0.0	Off	2,060	non-engaged	No
- 2.0	63 [101]	0.0	Off	2,010	non-engaged	No
- 1.5	38 [61]	0.0	Off	1,204	engaged	No
- 1.0	26 [42]	0.0	Off	316	engaged	No
- 0.5	37 [60]	0.0	Off	0	engaged	No
0.0	17 [27]	0.0	Off	0	engaged	No

Pre-Crash Data -5 to 0 sec [2 samples/sec] (Second Record, table 2 of 2)

Times (sec)	Driver Gear Selection	Traction Control via Brakes	Wheel Torque (Nm)	Occupant Size Classification, Front Passenger (Child Size Yes/No [Hex value])	Speed Control Telltale
- 5.0	Drive	non-engaged	300	No [$08]	Off
- 4.5	Drive	non-engaged	268	No [$08]	Off
- 4.0	Drive	non-engaged	-28	No [$08]	Off
- 3.5	Drive	non-engaged	-76	No [$08]	Off
- 3.0	Drive	non-engaged	-108	No [$08]	Off
- 2.5	Drive	non-engaged	-160	No [$08]	Off
- 2.0	Drive	non-engaged	-204	No [$08]	Off
- 1.5	Drive	non-engaged	-64	No [$08]	Off
- 1.0	Drive	non-engaged	1,936	No [$08]	Off
- 0.5	Drive	non-engaged	2,588	No [$08]	Off
0.0	Drive	non-engaged	4,268	No [$08]	Off

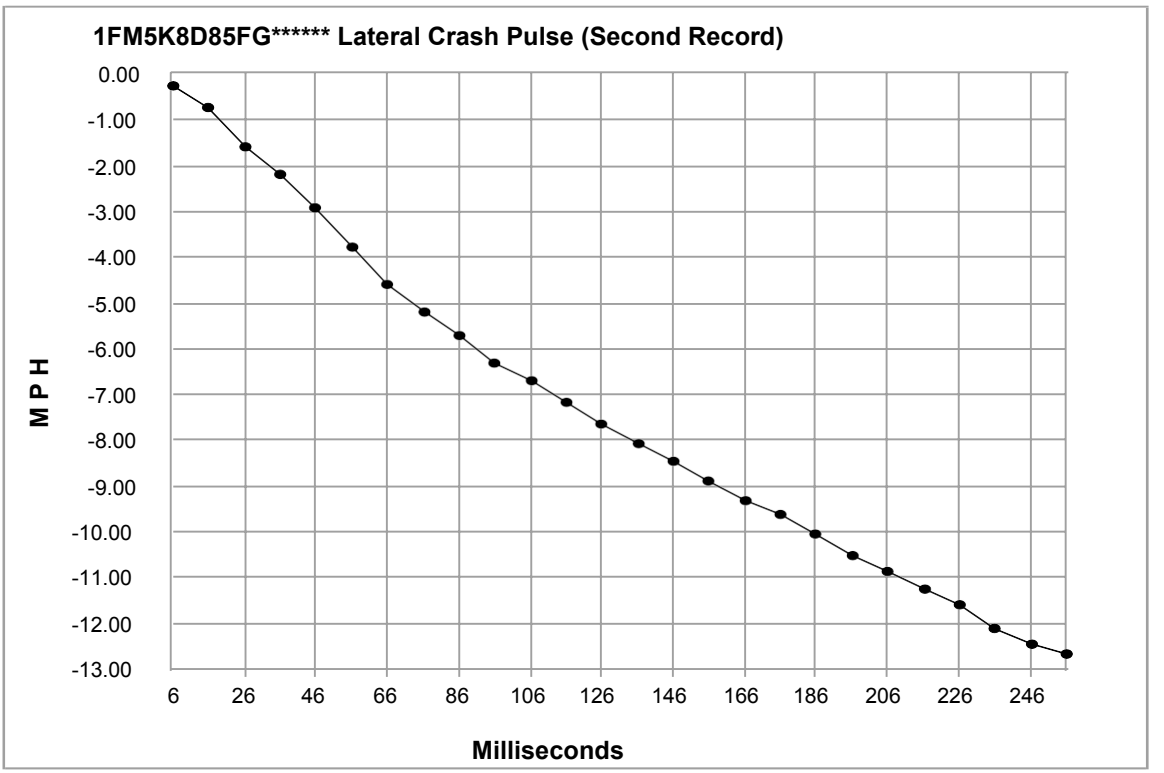
Pre-Crash Data -5 to 0 sec [10 samples/sec] (Second Record)

Times (sec)	Steering Wheel Angle (degrees)	Stability Control Lateral Acceleration (g)	Stability Control Longitudinal Acceleration (g)	Stability Control Yaw Rate (deg/sec)	Stability Control Roll Rate (deg/sec)
- 5.0	-1.0	-0.046	-0.014	0.31	-0.12
- 4.9	-0.8	-0.018	-0.019	0.22	-0.08
- 4.8	-0.7	-0.002	0.006	0.2	-0.84
- 4.7	-0.6	-0.01	-0.024	0.27	0.8
- 4.6	-0.8	-0.012	0.004	0.38	-0.64
- 4.5	-1.0	0.006	-0.021	0.27	-0.04
- 4.4	-0.8	-0.037	-0.012	0.11	0.92
- 4.3	-1.0	-0.058	-0.042	0.15	-0.56
- 4.2	-0.8	-0.011	-0.043	0.04	-1.16
- 4.1	-0.5	-0.022	-0.052	0.11	0.24
- 4.0	-0.6	-0.03	-0.036	0.4	0.72
- 3.9	-0.6	-0.079	-0.039	0.34	1.08
- 3.8	-0.5	-0.033	-0.071	0.2	1.56
- 3.7	-0.5	-0.025	-0.039	0.13	-1.4
- 3.6	0.1	-0.033	-0.06	0.02	-2.72
- 3.5	1.4	-0.002	-0.04	0.11	-0.52
- 3.4	0.6	-0.027	-0.058	0.7	-1.0
- 3.3	0.3	-0.006	-0.04	0.72	-1.2
- 3.2	0.4	0.001	-0.058	0.52	0.28
- 3.1	0.5	-0.006	-0.058	0.61	-0.48
- 3.0	0.4	-0.018	-0.084	0.61	-0.4
- 2.9	1.4	-0.004	-0.027	0.56	-0.2
- 2.8	1.9	-0.028	-0.076	0.7	0.52
- 2.7	5.6	0.047	-0.052	1.13	-0.04
- 2.6	19.0	0.176	-0.059	3.29	1.64
- 2.5	24.0	0.217	-0.053	6.79	2.36
- 2.4	24.3	0.273	-0.271	8.59	1.32
- 2.3	29.4	0.367	-0.249	9.34	2.52
- 2.2	30.9	0.425	-0.196	10.4	2.52
- 2.1	34.6	0.485	-0.084	11.15	2.56
- 2.0	21.6	2.0	-2.0	-14.84	28.92
- 1.9	11.9	-0.789	-0.117	-128.63	-34.64
- 1.8	-0.1	-0.935	-0.271	-146.11	-34.84
- 1.7	-0.1	-0.797	-0.143	-171.27	-8.68
- 1.6	-0.1	-0.526	-0.048	-180.0	2.8
- 1.5	-0.1	-1.084	0.173	-180.0	-12.8
- 1.4	-0.1	-0.83	0.056	-176.54	2.68
- 1.3	-0.1	-0.411	0.39	-148.27	44.2
- 1.2	-0.1	-0.745	0.658	-137.5	64.88
- 1.1	-0.1	-0.986	0.46	-133.04	-23.04
- 1.0	-0.1	-1.285	0.013	-148.38	-62.16
- 0.9	-0.1	-0.597	0.111	-145.93	0.88
- 0.8	-0.1	-0.15	0.081	-125.4	49.08
- 0.7	-0.1	0.171	0.444	-120.18	54.52
- 0.6	-0.1	0.984	1.081	-110.22	8.72
- 0.5	-0.1	0.341	0.092	-88.63	-38.12
- 0.4	-0.1	-0.196	0.205	-91.36	-7.44
- 0.3	-0.1	0.332	0.968	-93.88	7.56
- 0.2	-0.1	1.267	0.139	-101.2	20.6
- 0.1	-0.1	1.28	0.066	-81.81	27.92
0.0	-0.1	1.628	0.078	-37.79	28.96



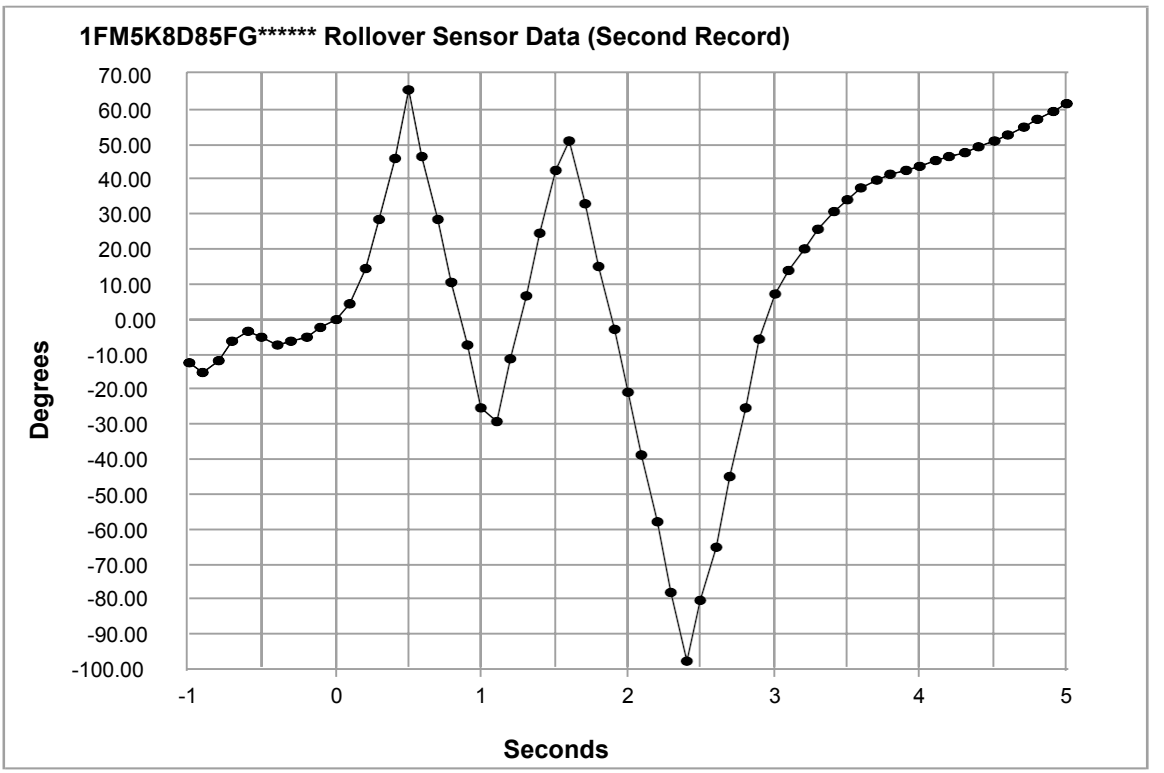
Longitudinal Crash Pulse (Second Record)

Time (msec)	Delta-V, longitudinal (MPH)	Delta-V, longitudinal (km/h)
5.5	-0.01	-0.02
15.5	0.03	0.05
25.5	0.06	0.10
35.5	0.03	0.05
45.5	0.22	0.35
55.5	0.18	0.30
65.5	0.10	0.17
75.5	0.12	0.20
85.5	0.14	0.22
95.5	0.15	0.24
105.5	0.20	0.31
115.5	0.25	0.40
125.5	0.24	0.38
135.5	0.30	0.48
145.5	0.30	0.48
155.5	0.38	0.61
165.5	0.41	0.67
175.5	0.48	0.77
185.5	0.43	0.69
195.5	0.44	0.70
205.5	0.50	0.80
215.5	0.50	0.80
225.5	0.52	0.84
235.5	0.49	0.78
245.5	0.50	0.81
255.5	0.54	0.87



Lateral Crash Pulse (Second Record)

Time (msec)	Delta-V, lateral (MPH)	Delta-V, lateral (km/h)
5.5	-0.24	-0.39
15.5	-0.74	-1.20
25.5	-1.59	-2.56
35.5	-2.19	-3.53
45.5	-2.92	-4.70
55.5	-3.78	-6.08
65.5	-4.59	-7.39
75.5	-5.21	-8.38
85.5	-5.69	-9.16
95.5	-6.30	-10.14
105.5	-6.69	-10.77
115.5	-7.15	-11.51
125.5	-7.66	-12.32
135.5	-8.07	-12.99
145.5	-8.46	-13.62
155.5	-8.88	-14.30
165.5	-9.30	-14.97
175.5	-9.63	-15.50
185.5	-10.06	-16.19
195.5	-10.52	-16.93
205.5	-10.84	-17.44
215.5	-11.23	-18.07
225.5	-11.60	-18.67
235.5	-12.08	-19.45
245.5	-12.45	-20.04
255.5	-12.65	-20.36



Rollover Sensor Data (Second Record)

Time (sec)	Vehicle Roll Angle (deg)
-1.0	-12.25
-0.9	-15.21
-0.8	-11.95
-0.7	-6.52
-0.6	-3.27
-0.5	-5.17
-0.4	-7.35
-0.3	-6.37
-0.2	-5.08
-0.1	-2.46
0.0	-0.12
0.1	4.63
0.2	14.39
0.3	28.29
0.4	45.74
0.5	65.54
0.6	46.41
0.7	28.4
0.8	10.39
0.9	-7.62
1.0	-25.65

Time (sec)	Vehicle Roll Angle (deg)
1.1	-29.38
1.2	-11.38
1.3	6.63
1.4	24.64
1.5	42.65
1.6	50.95
1.7	32.94
1.8	14.93
1.9	-3.07
2.0	-21.08
2.1	-39.09
2.2	-57.99
2.3	-77.9
2.4	-97.99
2.5	-80.62
2.6	-65.12
2.7	-45.27
2.8	-25.3
2.9	-5.56
3.0	7.14
3.1	13.77

Time (sec)	Vehicle Roll Angle (deg)
3.2	20.08
3.3	25.81
3.4	30.59
3.5	34.29
3.6	37.21
3.7	39.71
3.8	41.15
3.9	42.25
4.0	43.63
4.1	45.09
4.2	46.37
4.3	47.7
4.4	49.13
4.5	50.73
4.6	52.58
4.7	54.7
4.8	57.01
4.9	59.44
5.0	61.86

Hexadecimal Data

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

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Event Record 1


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69 E6 5C D4 3B E8 67 09 2E 1D 9F 11 48 04 47 0A 31 12 22 22 74 30 6A 4D 07 89 D6 DD
5E 48 2C C1 68 4C 80 DE 98 70 B0 02 A1 94 D4 7D BC EB A4 59 8C C7 74 35 20 68 38 FA
50 8C 68 1E 80 B0 98 42 35 CF BB 55 17 DB 1B 45 B4 A3 D5 1C C5 96 3B 0F D2 F6 D2 F6
D2 F6 EA F6 EB F6 0D F7 63 F8 43 F9 4F FA E7 FB 6E FC DC FF 43 F6 10 DE 8E D3 BC D4
B8 D1 7B 3E 7B 3E 7B 3E 7B 3E 7B 3E 7B 3E 7A 3E 7A 3E 77 3E 76 3E 78 3E 79 3E 7A 3E
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62 3E 62 3E 64 3E 65 3E 67 3E 6E 3E 70 3E 76 3E 7D 3E 7B 3E E3 07 CF 07 D9 07 B9 07
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9C 07 AC 07 A9 07 89 07 A9 07 94 07 A8 07 96 07 A8 07 96 07 96 07 7C 07 B5 07 84 07
9C 07 95 07 9B 07 C1 06 D7 06 0C 07 7C 07 CA 07 DB 07 C2 07 D8 07 C0 07 D0 07 CF 07
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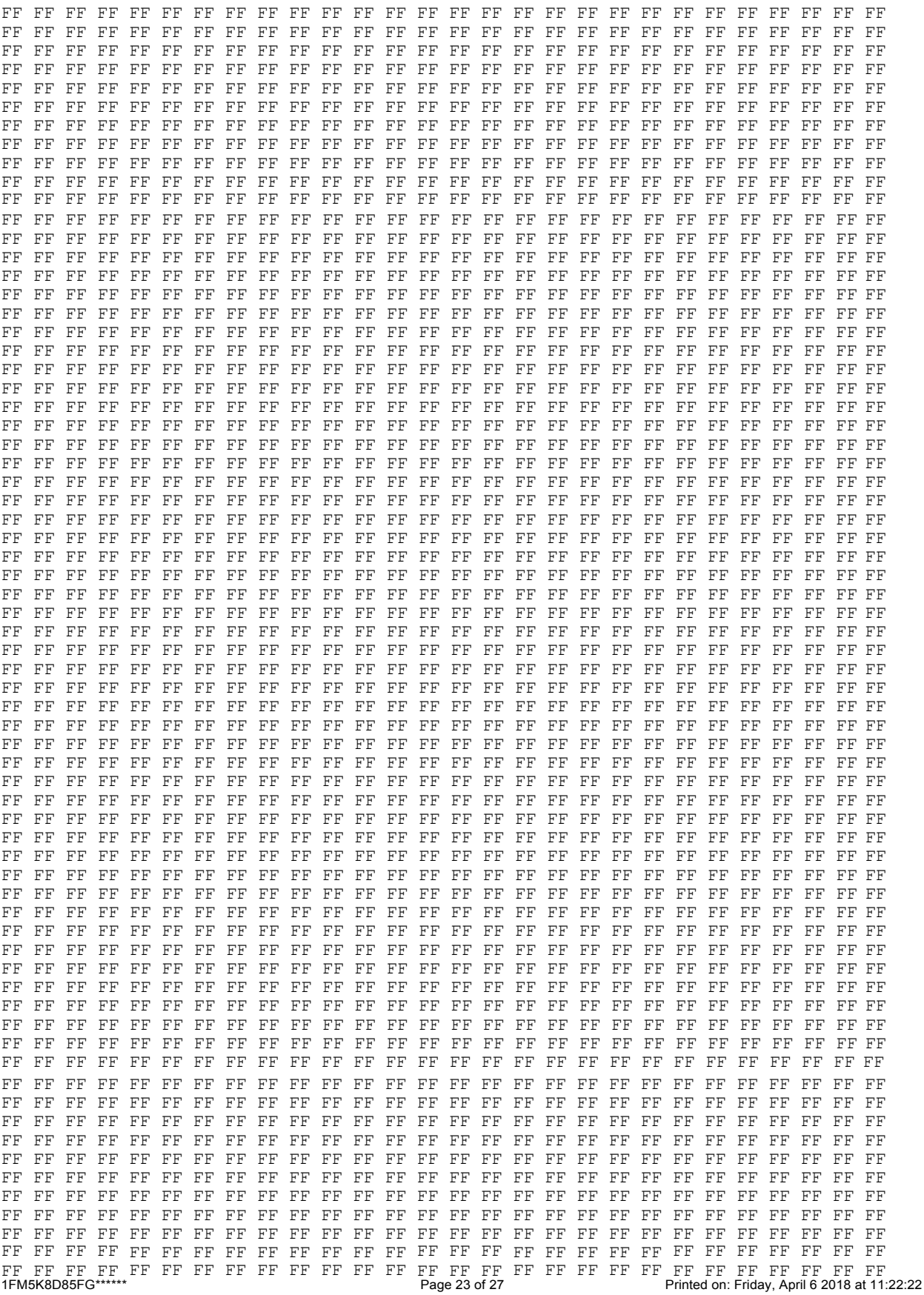

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Event Record 2


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3A CE FF FF 7C CC FF FF 8A C9 FF FF 70 C7 FF FF EA C4 FF FF EC C1 FF FF 1C BF FF FF
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DOT HS 812 588
August 2018

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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