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Special Crash Investigations On-Site Side Impact Crash Investigation
Vehicle: 2016 Chevrolet Malibu
Location: Florida
Crash Date: October 2016

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order 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 vehicle(s) 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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SPECIAL CRASH INVESTIGATIONS
CASE NO. CR16029
ON-SITE SIDE IMPACT CRASH INVESTIGATION
VEHICLE: 2016 CHEVROLET MALIBU
LOCATION: FLORIDA
CRASH DATE: OCTOBER 2016

BACKGROUND

An on-site investigation of the side impact crash of a 2016 Chevrolet Malibu that resulted in non-incapacitating (B-level) inju-ries to the belted 22-year-old female driver and belted 19-year-old female front row right occupant. The Malibu became involved in a side impact crash as it attempted a left turn across the oncoming lanes of a multi-lane roadway after traffic in the through lanes of the intersection yielded the right-of-way. However, a 2015 Chevrolet Tahoe in the oncoming right turn-only lane proceeded through a marked safety zone and into the intersection, where its front plane struck the Malibu on the forward aspect of its right plane (**Figure 1**). Multiple supplemental restraint systems in the Malibu deployed during the crash, and both of its occupants were transported by ambulances to local hospitals for treatment of their injuries.

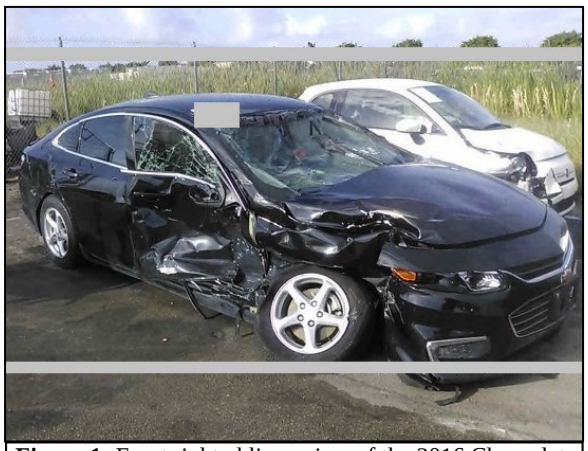


Figure 1: Front right oblique view of the 2016 Chevrolet Malibu.

This crash was identified by the Special Crash Investigations (SCI) team of Crash Research & Analysis, Inc., which notified the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration on October 31, 2016. The CID subsequently assigned an on-site investigation of the crash to the SCI team on November 3, 2016. Cooperation was established with the insurance vehicle salvage facility in possession of the Malibu on November 4, 2016. The on-site portion of this investigation took place November 9 and 10, 2016, and involved the documentation of the exterior and interior of the Malibu, including measurement of the structural deformation and intrusion, identification of occupant contact evidence, analysis of manual restraint usage, and documentation of supplemental restraint deployment/actuation. During the vehicle inspection process, the Malibu's event data recorder (EDR) was imaged using the Bosch Crash Data Retrieval (CDR) software and tool. The crash site was documented, and on-scene images were obtained from the investigating law enforcement agency. The Tahoe was owned and self-insured by a municipality, which did not cooperate for an SCI inspection of the vehicle. Multiple requests for medical record documentation concerning the injuries and treatment course for the Malibu's occupants were denied by the treating medical facility.

CRASH SUMMARY

Crash Site

The crash occurred on a multi-lane divided roadway at an intersection with a local roadway during daylight hours in October 2016. According to the National Weather Service, conditions in the locale at the time of the crash included overcast skies with a temperature of 31 °C (88 °F), 65 percent relative humidity, and a 26 km/h (16 mph) northeasterly breeze. The physical environment of the roadways and crash site was documented by the SCI investigator using a Nikon Nivo 5.M+ total station mapping system.

The multi-lane roadway had five lanes in the westbound direction and four lanes in the eastbound direction for the respective approaches to the intersection. It was divided by a 2.0 m (6.6 ft) wide grass median that was bordered with raised concrete curbs. The westbound portion consisted of a left turn-only lane, three travel lanes, and a right turn-only lane, all of which were 3.7 m (12.1 ft) wide. Similarly, the eastbound portion consisted of a left turn-only lane, two travel lanes, and a right turn-only lane, which also were all 3.7 m (12.1 ft) in width. Delineation for all lanes included single dashed-white lines for the travel lanes, single solid-white lines for the turn lanes, single solid-white fog lines, and single solid-yellow median lines. A marked safety zone, delineated by reflective white paint on the roadway's surface, served to channel traffic from the eastbound right turn-only lane onto the intersecting local roadway. The multi-lane roadway was straight and level, with no controls at the intersection. Speed was regulated by a posted limit of 72 km/h (45 mph). **Figure 2** depicts the roadway for the Malibu's westbound trajectory, while **Figure 3** depicts that of the Tahoe. The intersecting local roadway served as an entrance/exit to a residential subdivision. It consisted of three travel lanes, divided by a vegetated median with raised concrete curbs and a yellow safety zone painted at both ends. The average median width was 3.3 m (10.8 ft). The entrance lane was 4.8 m (15.7 ft) wide, while the left turn-only and right turn-only lanes of the exit were 3.8 m (12.5 ft) and 4.1 m (13.5 ft) wide, respectively. The local roadway curved right on approach to the intersection, where oncoming traffic was controlled by a painted stop bar and stop sign. A crash diagram is included at the end of this technical report on **Page 18**.

Figure 2: View of the Malibu's westbound pre-crash travel trajectory.

Figure 3: View of the Tahoe's eastbound pre-crash travel trajectory.

Pre-Crash

The 22-year-old female operated the Malibu westbound on the multi-lane roadway. She was accompanied by the 19-year-old female front row right occupant. Both people used the Malibu's 3-point lap and shoulder seat belt for manual restraint. The driver steered the vehicle into the left turn-only lane as she approached the intersection, with the intention of completing a left turn and entering the subdivision on the local roadway. She applied the brakes and brought the Malibu to a controlled stop at the end of the left turn-only lane.

According to a police crash report (PAR) that documented information concerning the crash, the driver of the Malibu had stated to the investigating law enforcement officer that she had brought the vehicle to a stop and was waiting in traffic to turn at the intersection. She had further stated that stopped vehicles had backed up traffic in the eastbound lanes, such that oncoming traffic was also stopped, and alleged that the lead vehicles in the eastbound lanes motioned her to complete her turn through the intersection. The Malibu's driver then accelerated the vehicle and began the left turn through the intersection. Her statements to the law enforcement officer were supported by additional documented statements from a witness to the crash. Further, these statements as discussed by the PAR were confirmed by the data imaged from the Malibu's EDR.

The Malibu's EDR report confirmed that both occupants were belted. It also revealed that the vehicle's speed decreased to 0 km/h (0 mph) over the first 1.5-second pre-crash interval. The Malibu remained stationary for approximately one second, whereupon the driver accelerated the vehicle over an approximate 2.5-second timeframe leading up to algorithm enable (AE). The vehicle's final pre-crash sample speed was 23 km/h (14.3 mph), with the accelerator pedal depressed 32 percent. There was no evidence of any avoidance action by the Malibu's driver prior to impact.

The Tahoe approached the intersection from the west. It was occupied by a 45-year-old male driver, who was police-reported as restrained by the vehicle's 3-point lap and shoulder seat belt. Due to the backup of traffic in the eastbound travel lanes, the Tahoe's driver proceeded to the right and entered the right-turn-only lane as he approached the intersection. Despite the marked safety zone and right turn-only markings, the driver of the Tahoe maintained a straight trajectory through the marked safety zone and continued into the intersection. Due to a combination of the lack of cooperation for inspection of the vehicle by the municipality that owned the Tahoe and a refusal of the driver for interview, it remains unknown if the driver of the Tahoe detected the turning Malibu prior to the crash, or if he provided any steering or baking avoidance input. However, there was no evidence found during the SCI crash site inspection to support any avoidance action by the Tahoe's driver prior to impact. Regardless, the front plane of the Tahoe approached the right plane of the turning Malibu.

Crash

The Tahoe's front plane struck the Malibu's right plane (Event #1) in the intersection. Directions of force were in the 2 o'clock sector for the Malibu and the 11 o'clock sector for the Tahoe. According to the data imaged from the Malibu's EDR, the maximum longitudinal and lateral delta-Vs associated with this impact were -18 km/h (-11.2 mph) and -45 km/h (-28.0 mph), respectively. Using this data, the resultant angle of the principal direction of force was calculated to be 68 degrees. The forward aspect of the Malibu's right plane and the front plane of the Tahoe began to deform as the vehicles crushed to maximum engagement. A rapid counterclockwise rotation to the Malibu and a clockwise rotation to the Tahoe were induced. The vehicles rotated in their respective directions and were deflected from the point of impact to the east-southeast. After the Malibu had rotated approximately 80 degrees counterclockwise and the Tahoe had rotated approximately 60 degrees clockwise, the rear aspect of the Tahoe's left plane side- slapped the rear aspect of the Malibu's right plane (Event #2). Minor deformation was sustained by both vehicles during the brief engagement. Directions of force were in the 3 o'clock sector for the Malibu and the 9 o'clock sector for the Tahoe.

The Malibu and Tahoe maintained their respective rotations and continued on their deflected trajectories toward the east-southeast. The Malibu overrode the curb at the southeast intersection quadrant and continued on a left-arching trajectory into the grass roadside. It then re-entered the multilane roadway approximately 8 m (26 ft) east of the intersection and came to an uncontrolled final rest, facing north in the center of the eastbound portion of the roadway (**Figure 4**).

Figure 4: East-facing view of the multilane roadway and the Malibu at final rest (on-scene image obtained from the investigating law enforcement agency).

Figure 5: North-facing view of the Tahoe at final rest (on-scene image obtained from the investigating law enforcement agency).

Following the side-slap event, the Tahoe maintained its clockwise rotation. It achieved a left side-leading attitude, and an instability was created by the lateral drag force on the Tahoe's left side tires with respect to the vehicle's center of mass. Evidenced by a tire mark and gouge from the left rear wheel rim, the Tahoe tripped into a left side-leading rollover sequence. It rolled one quarter-turn onto its left plane (Event #3) and then slid to final rest while continuing its clockwise rotation. The Tahoe came to rest facing northwest, straddling the stop bar at the end of the intersecting local roadway's right turn-only lane (**Figure 5**).

Post-Crash

Local law enforcement, fire department, and emergency medical services (EMS) personnel responded to the crash scene. The Malibu's driver and front row right occupant were assisted from the vehicle and transported by ambulances to local hospitals for treatment of their injuries. Emergency response personnel cut the windshield of the Tahoe and assisted its driver from the vehicle then transported him by ambulance to a local hospital. Photographs of the vehicles and overall crash site were obtained by the investigating law enforcement agency. A local towing service removed the Malibu from the crash site and transferred it to a local yard. It was later moved by its insurer to the insurance vehicle salvage facility where it was located for this SCI investigation. The local municipality removed the Tahoe and transferred it to an unknown location.

2016 CHEVROLET MALIBU

Description

The 2016 Chevrolet Malibu (**Figure 6**) was a five passenger sedan manufactured in December 2015 and was identified by the VIN 1G1ZB5ST6GFxxxxxx. It was equipped with the LS trim package. The vehicle's odometer reading at the time of the SCI inspection was 19,690 km (12,235 mi). The body was configured on a 274 cm (107.9 in) wheelbase with front-wheel drive. It was powered by a 1.5 liter inline 4-cylinder gasoline engine that was linked to an automatic transmission, with a center console- mounted shifter.

Figure 6: Front right oblique view of the Malibu.

The Malibu's gross vehicle weight rating was placarded at 1,835 kg (4,046 lb). Front and rear gross axle weight ratings were 952 kg (2,099 lb) and 883 kg (1,947 lb), respectively. The vehicle's curb weight was 1,625 kg (3,583 lb). The manufacturer's recommended tire size was P205/65R16 at a recommended pressure of 240 kPa (35 PSI) for all four tires. At the time of the SCI vehicle inspection, the Malibu was equipped with four Firestone FT140 tires of the recommended size mounted on OEM aluminum wheels. The tires had matching Tire Identification Numbers of 8X84 FTO 4615. Specific tire data measured during inspection were as follows:

	Measured Tire Pressure	Measured Tread Depth	Restriction	Damage
LF	207 kPa (30 PSI)	6 mm (8/32 in)	No	None
LR	214 kPa (31 PSI)	4 mm (5/32 in)	No	None
RR	214 kPa (31 PSI)	6 mm (7/32 in)	No	None
RF	Tire Flat	5 mm (6/32 in)	Yes	Cut in sidewall

The Malibu was configured for the seating of up to five occupants (2/3). The front seats were bucket seats with manual seat track and seatback recline adjustments, and equipped with adjustable head restraints. At the time of the SCI inspection, the driver's seat was adjusted to the full-rear track position, with the seatback slightly reclined and the adjustable head restraint 1 cm (0.4 in) upward. The front row right seat was also adjusted to the rearmost track position with the seatback slightly reclined, but the head restraint was adjusted 7 cm (2.8 in) upward. The second row consisted of a bench seat with adjustable head restraints at the outboard positions. Both were adjusted 8 cm (3.2 in) upward. Manual restraint systems consisted of 3-point lap and shoulder seat belts for all five seats. Supplemental restraints included Certified Advanced 208-Compliant (CAC) driver and passenger frontal air bags, driver and front passenger knee air bags, seat-mounted side impact air bags for both the front and second row outboard positions, and inflatable curtain (IC) air bags. The Malibu was equipped with a steering column that featured both tilt and telescopic manual adjustments. At the time of the SCI inspection, the tilt was adjusted fully-upward, with the telescopic fully-rearward.

Exterior Damage

The Malibu sustained impact damage to its right plane, consistent with the right plane impact and subsequent side-slap (crash events #1 and #2). Direct contact damage from the first impact from the Tahoe's front plane was located at the forward aspect of the Malibu's right plane. It began at the right front bumper corner and extended 233 cm (91.7 in) rearward along the right front fender, right front door, and onto the right rear door (**Figure 7**). The direct contact ended 12 cm (4.7 in) rearward of the rear edge of the right front door. Noteworthy characteristics of the damage included a distinct area of vertically oriented deformation immediately forward of the Malibu's right front tire/wheel, as well as a similar impression at the right A-pillar. This damage matched the profile of the aftermarket bumper guard affixed to the Tahoe's front plane. An additional characteristic of note was the arching rubber transfer at the forward aspect of the right rear door, attributable to the left front tire of the Tahoe. This evidenced the alignment, rotation, and side-slap of the vehicles during the crash.

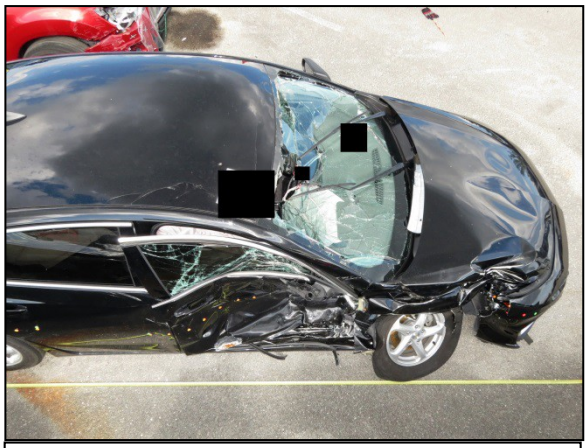


Figure 7: Overhead view of the Event 1 damage pattern to the right plane of the Malibu.

A residual crush profile was documented by the SCI investigator using a Nikon Nivo 5.M+ total station. The crush at mid-door level was measured using a Field-L length of 233 cm (91.7 in), beginning at the right front bumper corner and extending rearward. The results were as follows: C1 = 0 cm (0 in), C2 = 19 cm (7.5 in), C3 = 21 cm (8.3 in), C4 = 22 cm (8.7 in), C5 = 23 cm (9.1 in), C6 = 14 cm (5.5 in). Maximum crush measured 30 cm (11.8 in) to the right front door, between the C2 and C3 measurement locations.

The Collision Deformation Classification (CDC) assigned to the Malibu's damage pattern (**Figure 8**) related to the Event 1 impact was 02RYEW3. Using the documented measurements, the "Missing Vehicle" algorithm of the WinSMASH model was used to calculate the vehicle velocity change for the crash event. The total calculated delta-V was 24 km/h (14.9 mph), which appeared reasonable. Longitudinal and lateral components of the calculated delta-V were -12 km/h (-7.5 mph) and -21 km/h (-13.0 mph), respectively.

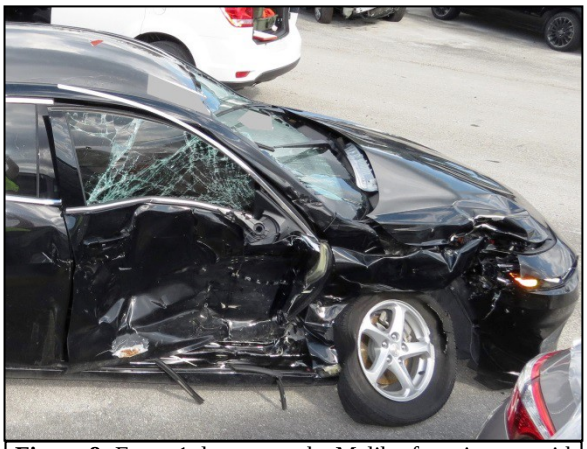


Figure 8: Event 1 damage to the Malibu from impact with the Tahoe's front plane.

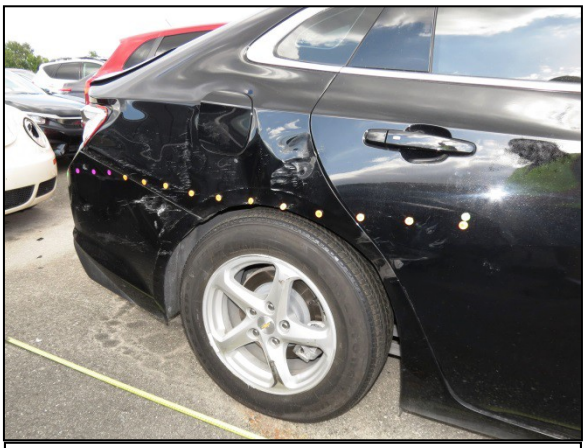


Figure 9: View of the Event 2 damage pattern to the right plane of the Malibu.

Damage from the Event #2 side-slap was located on the rear aspect of the Malibu's right plane. Direct contact began 50 cm (19.7 in) forward of the right rear axle position and extended 141 cm (55.5 in) rearward to the right rear bumper corner (**Figure 9**). In the damage pattern was minor lateral crush and deformation to surrounding components. A residual crush profile was also documented by the SCI investigator using the total. The crush at mid-door level was measured using a Field-L length of 141 cm (55.5 in), which matched the location and width of the direct contact damage. Resultant crush measurements were: C1 = 8 cm (3.2 in), C2 = 7 cm (2.8 in), C3 = 5 cm (2.0 in), C4 = 4 cm (1.6 in), C5 = 1 cm (0.4 in), C6 = 0 cm (0 in). Maximum crush was the C1 measurement. The CDC assigned to the Event 2 side-slap damage was 03RBEW1. Based on the measurements, the damage algorithm of the WinSMASH model was used to calculate the vehicle velocity change (delta-V) for the crash event. The total calculated delta-V was 13 km/h (8.1 mph). Longitudinal and lateral components of the calculated delta-V were 0 km/h (0 mph) and -13 km/h (-8.1 mph), respectively. These results were reasonable.

Event Data Recorder

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

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

If power supply to the SDM was lost following a crash event, all or part of the data may not have been recorded to the EDR's memory. The EDR had the capacity to record 300 milliseconds of data once the minimum threshold was achieved in longitudinal or lateral events, or 700 milliseconds for rollover events. Associated to the recording of each respective event was a 5-second pre-crash buffer that recorded multiple pre-crash data points in 0.5 second intervals. Data recorded included accelerator pedal (% full), service brake (on/off) status, engine speed (RPM), engine throttle (% full), vehicle speed (mph), cruise control state, and engine torque data. System status data, inclusive of reported diagnostic trouble codes, seat belt usage of front row occupants, and vehicle ignition cycle at the time of the event were also recorded.

The imaged data contained one recorded event, which was a "Deployment" event type. It occurred on ignition cycle 1,719, and the data was imaged on ignition cycle 1,720. Based on the cycle count, the recorded event was related to this investigated crash. Pre-crash data associative to the event were summarized as follows:

Time	Accelerator Pedal (% Full)	Service Brake	Engine rpm	Engine Throttle (% Full)	Vehicle Speed
-5.0	0	ON	960	23	8 km/h (5 mph)
-4.5	0	ON	896	23	6 km/h (3.7 mph)
-4.0	0	ON	832	23	2 km/h (1.2 mph)
-3.5	0	ON	832	23	0 km/h (0 mph)
-3.0	0	OFF	832	22	0 km/h (0 mph)
-2.5	27	OFF	1,472	57	2 km/h (1.2 mph)
-2.0	27	OFF	1,920	78	7 km/h (4.3 mph)
-1.5	32	OFF	2,240	70	12 km/h (7.5 mph)
-1.0	32	OFF	2,496	58	18 km/h (11.2 mph)
-0.5	32	OFF	3,008	53	23 km/h (14.3 mph)

The first event record included a longitudinal delta-V of -18 km/h (-11.2 mph) and a lateral delta-V -45 km/h (-28.0 mph). These maximums occurred at 176 milliseconds after algorithm enable

(AE). At the time of the first event record, both the driver's and front right passenger's seat belt status was "Buckled." The supplement restraint system deployment/actuation commands associated with the second event record are listed in the following table:

Device	Time After AE (milliseconds)
Pretensioner, driver	33
Pretensioner, right front passenger	33
Pretensioner loop #2, driver	38
Pretensioner loop #2, Right front passenger	38
Frontal air bag, 1st Stage, driver	40
Frontal air bag, 1st Stage, right front passenger	40
Knee air bag, driver	40
Knee air bag, right front passenger	40
Frontal air bag, 2nd Stage, driver	42
Side curtain air bag, left	40
Side curtain air bag, right	40
Side air bag, right front passenger	44
Side air bag, second row right	44
Frontal air bag, 2nd Stage, right front passenger	45

Interior Damage

The interior of the Malibu sustained moderate damage that consisted of supplemental restraint deployment, occupant compartment intrusion, and occupant contact. All the vehicle's doors remained closed during the crash, and the right front door became jammed shut due to deformation associated with the impact. The remaining doors were operational at the time of the SCI inspection. The AS-1 laminated windshield and AS-2 laminated right front glazing were both fractured as a result of the impact. The remaining glazing all remained intact and undamaged. None of the glazing was contacted by either of the occupants.

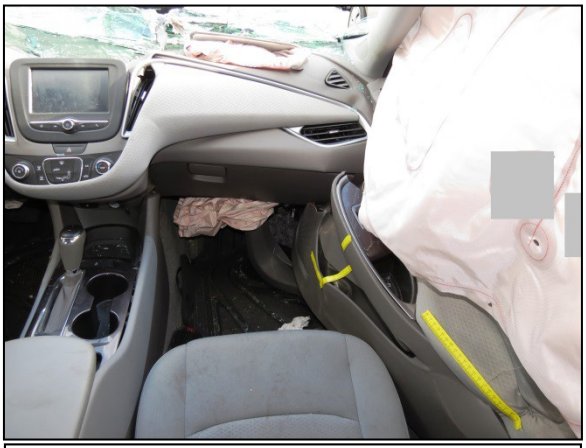


Figure 10: Intrusion of the right front door in the Malibu as viewed from above the front row right seat position.

Occupant compartment intrusion was limited to the intrusion of the right front door due to its direct involvement in the impact and the corresponding deformation. The maximum intrusion measured 17 cm (6.7 in), located at the forward lower quadrant of the door. The forward aspect of the intruded door was also engaged against, and had induced deformation to, the right aspect of the instrument panel. Despite the intrusion of its forward aspect, the rear aspect of the right front door was minimally intruded (**Figure 10**). The use of the manual restraint system by the Malibu's occupants and the deployment of the multiple air bag systems reduced the likelihood of their interaction with interior components during the crash.

The right plane impacts resulted in forces that induced both occupants to a kinematic response that was primarily to the right and slightly forward, toward the location of the impact. The SCI investigator inspected all interior components of the vehicle surrounding the driver and front row right occupant, inclusive of the instrument panel, center console, steering wheel, front door panels, A- and B-pillars, windshield, windshield header, and side glazing.

The only discernable evidence of occupant contact included slight rightward deformation of the center console and evidence of occupant loading to the right front door panel. The console deformation resulted from driver loading by her right thigh and right flank in response to the lateral component of the crash forces. Similarly, the occupant loading of the right front door panel resulted from contact by right flank of the front row right occupant in response to the lateral component of the crash forces. **Figure 11** depicts the aforementioned occupant contact in the Malibu, highlighted by yellow evidence marking tape.

Figure 11: Occupant contact from the driver and front row right occupant in the Malibu.

Manual Restraint Systems

The Malibu was equipped with 3-point lap and shoulder seat belts for all five seats. Each front seat belt consisted of continuous-loop webbing, a sliding latch plate, and a fixed height position D-ring. The driver's seat belt webbing retracted onto an emergency locking retractor (ELR), while the front right and all three rear seat belts used switchable automatic locking retractors (ALR)/ELR. Both front seat belts were further equipped with retractor and lower anchor pretensioners.

Inspection of the driver's seat belt found the webbing loosely retracted. Once extended, a distinct area of loading from the latch plate on the webbing was visible from 56 to 61 cm (22.0 to 24.0 in) above the lower anchor (**Figure 12**). There was also distinct loading from the D-ring, located 57-61 cm (22.4-24.0 in) above the latch plate loading. Based on the status of the driver's seat belt system and the imaged EDR data, the SCI investigator determined that the driver was belted at the time of the crash.

Figure 12: Latch plate loading on the Malibu driver's seat belt webbing.

The front row right seat belt was also loosely retracted against the B-pillar. Like the driver's there were two distinct areas of loading from the latch plate and D-ring. These were located 58 to 62 cm (22.8 to 24.4 in) and 121 to 127 cm (47.6 to 50.0 in) above the lower anchor, respectively. **Figure 13** depicts the latch plate and corresponding loading evidence on the webbing. Based on the status of the front row right seat belt and a review of the Malibu's imaged EDR data, the SCI investigator determined that the front row right occupant was belted at the time of the crash.

Figure 13: Latch plate and loading evidence on the webbing of the front row right seat belt system in the Malibu.

Supplemental Restraint Systems

The Malibu was equipped with multiple inflatable supplemental restraints. The first was a Certified Advanced 208-Compliant (CAC) frontal air bag for the driver and front right passenger positions. It consisted of a steering wheel hub-mounted driver air bag and a top instrument panel-mounted front right passenger air bag. The CAC system also incorporated seat belt buckle switch sensors, a front right occupant presence (weight) sensor, and front seat belt retractor and lower anchor pretensioners. Additional occupant protection in the Malibu was provided by driver and front right passenger knee air bags, front seat-mounted side impact air bags, second row outboard seat-mounted side impact air bags, and dual-sensing (side impact and rollover) inflatable curtain air bags. All air bags in the Malibu deployed as a result of the crash except the left front and second row left seat-mounted air bags.

The driver's frontal air bag (**Figure 14**) deployed from the steering wheel hub-mounted module without damage or occupant contact to the module cover flaps. In its deflated state, the air bag measured 68 cm (26.8 in) in overall diameter. There was a 16 cm (6.3 in) diameter center stitch pattern, to which internal tethers were affixed. Small 3 cm (1.2 in) diameter vents were located on the rear of the air bag. Nomenclature included "5469B" on the backside and "5470B" on the face. There was no discernable occupant contact or crash-related damage to the driver's CAC frontal air bag.

Figure 14: Deployed driver's frontal air bag in the Malibu.

The driver's knee air bag (**Figure 15**) deployed from the bottom of the left lower instrument panel without damage. In its deflated state, the air bag measured approximately 52 cm (20.5 in) wide and was 33 cm (13.0 in) tall. The air bag was not vented. The knee air bag was designed to deploy out and upward along the contour of the lower instrument panel. No discernable contact evidence was visible to the face of the driver's knee air bag, and no crash-related damage was observed. There were some post-crash stains on the fabric of the air bag from an undetermined source.

Figure 15: Deployed driver's knee air bag in the Malibu.

Figure 16: Deployed passenger's frontal air bag in the Malibu.

The passenger's frontal air bag (**Figure 16**) deployed from the top instrument panel-mounted module through the 28 cm (11.0 in) wide by 11 cm (4.3 in) tall cover flaps without damage or occupant contact to the module cover flaps. In its deflated state, the air bag measured 68 cm (26.8 in) tall and 52 cm (20.5 in) wide. There were two vents on each side of the air bag, including a 6 cm (2.4 in) diameter upper vent and a 1 cm (0.4 in) diameter lower vent. Overall, the air bag's face was clean, and there was no discernable occupant contact or crash-related damage to the passenger's frontal air bag. However, there were multiple punctures to the fabric of the air bag from post-crash contact with the fractured windshield glazing.

The front right passenger's knee air bag (**Figure 17**) deployed from the bottom of the right lower instrument panel without damage. Like the driver's knee air bag, it measured approximately 52 cm (20.5 in) wide and 33 cm (13.0 in) tall. The air bag was not vented. It was similar in design to the driver's knee air bag. No discernable contact evidence was visible to the face of the front right passenger's knee air bag, and no crash-related damage was observed.

Figure 17: Deployed front right passenger's knee air bag in the Malibu.

The front right passenger's seat-mounted side impact air bag deployed from the outboard aspect of the seatback. In its deflated state, the air bag measured 58 cm (22.8 in) tall by 28 cm (11.0 in) wide. There was a 4 cm (1.6 in) vent on the outboard aspect of the air bag. Nomenclature included "Nov 18 15." Although there was no discernable occupant contact visible to the air bag, it was likely contacted by the front row right occupant during the crash. Of note, the outboard aspect of the air bag contacted the fascia of the right B-pillar during deployment, resulting in abrasions to the fascia and polymer transfer on the outboard aspect of the air bag. **Figure 18** depicts this contact, with the air bag visible, as viewed from the second row facing forward.

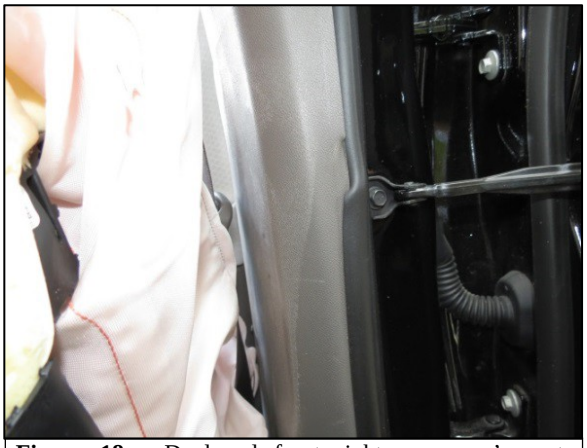


Figure 18: Deployed front right passenger's seat-mounted air bag and B-pillar contact in the Malibu.

The second row right seat-mounted side impact air bag deployed from the outboard aspect of the seatback through 48 cm (18.9 in) of stitching. In its deflated state, the air bag measured 52 cm (20.5 in) tall by 23 cm (9.1 in) wide. Nomenclature included "Nov 23 2015." No occupant was in proximity to this air bag when it was deployed; therefore, there was no occupant contact to the second row right seat-mounted air bag. There also was no crash-related damage. **Figure 19** depicts the deployed second row right seat-mounted side impact air bag.

Figure 19: Deployed second row right seat-mounted air bag in the Malibu.

Figure 20: Deployed right IC air bag in the Malibu.

The left and right IC air bags deployed from the roof side rails through the headliner. In their deflated states, both air bags measured approximately 190 cm (74.8 in) in overall length. There was 50 cm (19.7 in) of vertical coverage at the front row positions, 40 cm (15.7 in) at the B- pillars, and 40 cm (15.7 in) at the second row positions. When deflated, the IC air bags extended approximately 15 cm (5.9 in) below the beltline of the vehicle. There was no discernable occupant contact to either of the IC air bags. **Figure 20** depicts the deployed right IC air bag.

2016 CHEVROLET MALIBU OCCUPANT DATA

Driver Demographics

Age/Sex:	22 years / female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat Type:	Forward-facing bucket seat with adjustable head restraint
Seat Track Position:	Rearmost
Manual Restraint Usage:	3-point lap and shoulder seat belts
Usage Source:	Vehicle inspection
Air Bags:	Front, knee, seat-side impact, and left IC air bags available; Front, knee and IC air bags deployed
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Exited vehicle with some assistance
Transport From Scene:	Ambulance to a local hospital
Type of Medical Treatment:	Treatment unknown, records requested

Driver Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component (IPC)	IPC Confidence
-	Unknown	-	-	-

Source – Multiple requests denied by the treating facility

Driver Kinematics

The 22-year-old female driver was seated with the seat to its rearmost track position with the seat-back slightly reclined and the adjustable head restraint 1 cm (0.4 in) upward. She used the available 3-point lap and shoulder seat belt for manual restraint, evidenced by the loading found on the system during the SCI inspection and confirmed by the data imaged from the Malibu's EDR.

While the driver operated the Malibu westbound on the multilane roadway, she steered the vehicle into the left turn-only lane and decelerated. The driver waited in stop-and-go traffic at the intersection, confirmed by the data imaged from the vehicle's EDR. Oncoming traffic backed up in the eastbound lanes, and the lead vehicles provided the Malibu with the right of way to complete the left turn. The driver of the Malibu accelerated the vehicle and initiated the turn. There was no evidence of avoidance action by the driver prior to impact. It is likely, though unable to be confirmed, that the driver did not detect the Tahoe prior to impact due to the back-up of traffic at the intersection. At impact with the Tahoe, the driver initiated a right and slightly forward trajectory. She loaded the seat belt system, which restricted her movement in the vehicle's interior.

As the Malibu and Tahoe struck, a rapid counterclockwise rotation to the Malibu was induced. This accentuated the driver's right trajectory, and her right thigh and right flank contacted and loaded the center console. This deformed the console to the right. The driver then rebounded to the left as the Malibu was displaced to the east and came to uncontrolled rest in the roadway. Following the crash, the driver was assisted from the vehicle by emergency response personnel and transported by ambulance to a local hospital for the treatment of police-reported non-incapacitating (B-level) injuries. Specific injuries sustained by the driver remain unknown, due to a lack of cooperation by the treating medical facility.

Front Row Right Occupant Demographics

Age/Sex:	19 years / female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat Type:	Forward-facing bucket seat with adjustable head restraint
Seat Track Position:	Rearmost
Manual Restraint Usage:	3-point lap and shoulder seat belt system
Usage Source:	Vehicle inspection
Air Bags:	Front, knee, side impact, and right IC air bags available; all deployed
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Exited vehicle with some assistance
Transport From Scene:	Ambulance to a local hospital
Type of Medical Treatment:	Treatment unknown, records requested

Front Row Right Occupant Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component (IPC)	IPC Confidence
-	Unknown	-	-	-

Source – Multiple requests denied by the treating facility

Front Row Right Occupant Kinematics

The 19-year-old female was seated in the front row right bucket seat of the Malibu. Based on the observations of the SCI inspection, she had adjusted the seat to its rearmost track position with the seatback slightly reclined and the adjustable head restraint 7 cm (2.8 in) upward. She used the available 3-point lap and shoulder seat belt for manual restraint, evidenced by the loading found on the system during the SCI inspection and confirmed by the data imaged from the Malibu's EDR.

At impact with the Tahoe, the front row right occupant initiated a right and slightly forward trajectory. She loaded the seat belt system, which restricted her movement in the vehicle's interior. As the Malibu and Tahoe struck, a rapid counterclockwise rotation to the Malibu was induced.

The rapid rotation accentuated her right trajectory, and her right thigh and right flank contacted and loaded the intruding right door panel. The right armrest was deformed by the contact. She then rebounded to the left as the Malibu was displaced to the east coming to uncontrolled rest in the roadway. Following the crash, the front row right occupant was assisted from the vehicle through the left front door by emergency response personnel. She was transported by ambulance to a local hospital, where she received treatment for police-reported non-incapacitating (B-level) injuries. The specific injuries sustained by the front row right occupant remain unknown, due to a lack of cooperation by the treating medical facility.

2015 CHEVROLET TAHOE

Description

The 2015 Chevrolet Tahoe was an SUV identified by the VIN 1GNLC2EC8FRxxxxxx. **Figure 21** depicts the Chevrolet Tahoe in an on-scene law enforcement image that has been rotated 90 degrees. Based on the vehicle's VIN, the Tahoe was a rear-wheel drive law enforcement vehicle with a 295 cm (116 in) wheelbase. It was powered by a 5.3 liter V-8 gasoline engine, and weighed 2,397 kg (5,284 lb). The Tahoe was owned and self-insured by a municipality. Of note, it was equipped with an aftermarket bumper guard on its front plane and an emergency warning light-bar on its roof. Further interior equipment remains unknown. Following the crash, it was recovered from the crash site and transferred to an unknown location. The owner refused to allow an SCI inspection of the vehicle. On-scene images of the overturned vehicle served as the basis for the SCI vehicle condition and damage assessment.

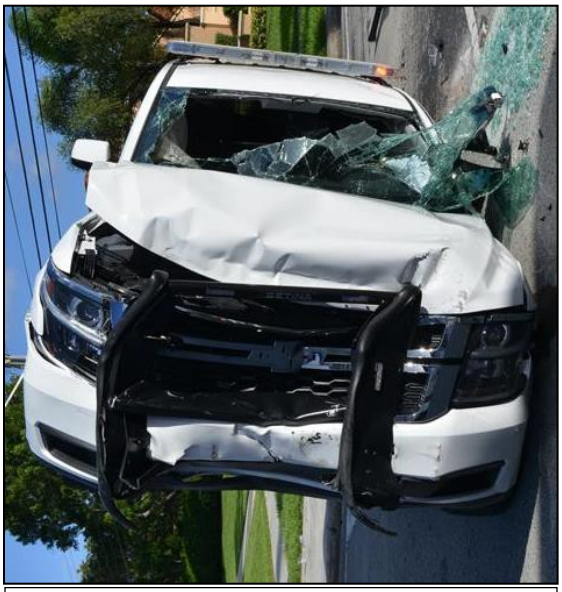


Figure 21: View of the Tahoe's front plane damage (on-scene image obtained from the investigating law enforcement agency).

Vehicle Damage

The Tahoe sustained front and left plane damage associative to the multiple event crash. Frontal damage spanned the entire width, and included deformation to the bumper beam, aftermarket bumper guard, grille, hood, and surrounding fascia/trim. It appeared that the bumper guard absorbed significant force during the crash. Based on the damage to the Malibu and Tahoe, it was evident that the right front wheel/tire of the Malibu was aligned with the Tahoe's centerline at the onset of the Event 1 impact. This was evidenced by the deformation from the bumper guard in the Malibu's damage pattern, along with black rubber transfer on the white bumper fascia of the Tahoe. The estimated CDC assigned to the Tahoe for the Event 1 impact with the Malibu was 11FDEW2.

Figure 22: View of the overturned Tahoe at final rest depicting undamaged planes (on-scene image obtained from the investigating law enforcement agency).

Due to the positioning of the Tahoe on its left plane in all of the available images of the vehicle, the specific location and severity of the Event 2 side-slap event damage remains unknown. The CDC assigned for the side-slap was 09L99999. The CDC assigned for the one quarter-turn rollover was 00LDAO99. **Figure 22** depicts the overturned Tahoe at final rest, where it is evident that the top, back, and right planes did not sustain damage during the crash.

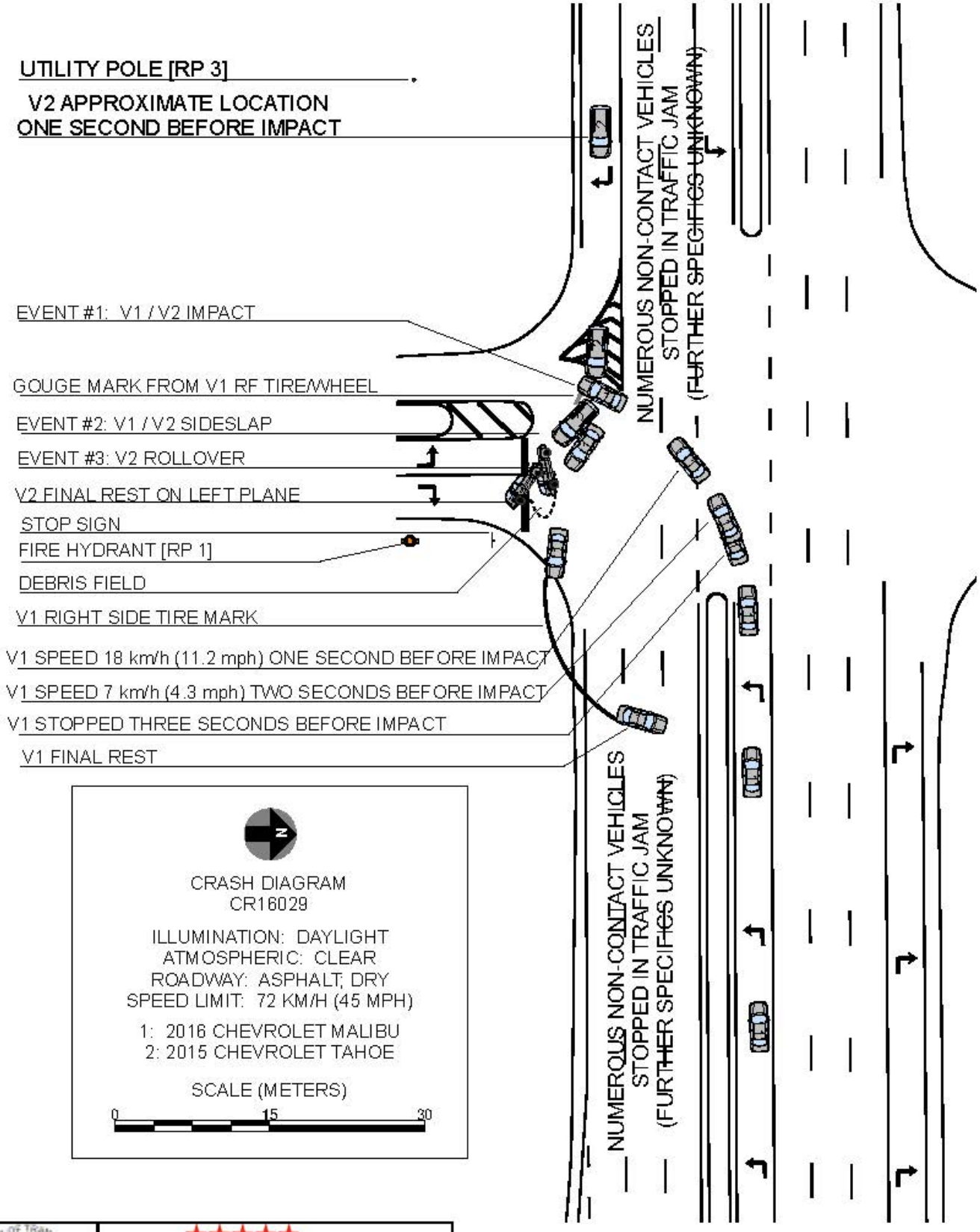
Figure 23: View of the interior of the overturned Tahoe (on-scene image obtained from the investigating law enforcement agency).

Occupant Data

The Tahoe was operated by the 45-year-old male at the time of the crash. According to the PAR, he was restrained by the vehicle's available 3-point lap and shoulder seat belt. Post-crash images of the Tahoe revealed that multiple air bags deployed as a result of the crash, including the steering wheel hub-mounted CAC frontal air bag, driver's seat-mounted side impact air bag, and both the left and right IC air bags (**Figure 23**). Emergency response personnel cut and removed the Tahoe's windshield then assisted the driver from the vehicle. He was transported by ambulance to a local hospital for the treatment of police-reported non-incapacitating (B-level) injuries. Specific injuries sustained by the Tahoe's driver and his course of treatment remain unknown.

CRASH DIAGRAM

CR16029



	NHTSA www.nhtsa.gov
Case Number:	CR16029

APPENDIX A:

2016 Chevrolet Malibu Event
Data Recorder 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	1G1ZB5ST6GF******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	CR16029_V1_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 17.0
Imaged with Software Licensed to (Company Name)	Company Name information was removed when this file was saved without VIN sequence number
Reported with CDR version	Crash Data Retrieval Tool 17.6.1
Reported with Software Licensed to (Company Name)	U.S. DOT / NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Record 1 (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, pretensioners, or roll bars:

-Head Rest Deployment
-Battery Cut-Off Deployment

The second type of SDM recorded crash event for FSR Events is the Deployment Event. It also may contain 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.
There are two types of PedPro crash events. The first is the Non-Deployment PedPro Event. A Non-Deployment PedPro Event records data but does not deploy anything. A Non-Deployment PedPro Event may contains Pre-Crash and Crash data. The second type of PedPro recorded crash event is the Deployment PedPro Event. It also may contain Pre-Crash and Crash data. Deployment Events cannot be overwritten or cleared by the SDM.
The SDM can store up to two PedPro Events.

Data:

For FSR Events, SDM Recorded Vehicle Velocity Change reflects the change in velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. For Deployment and Non-Deployment Events, the SDM will record up to 300 milliseconds of data after time zero. The SDM will also record up to 300 milliseconds of Vehicle Acceleration data after time zero.
For Rollover Events, the SDM may record Lateral Acceleration, Vertical Acceleration, and Roll Rate data, if the SDM is rollover capable. This data reflects what the sensing system experienced during the recorded portion of the event. For Rollover Deployment Events, the SDM will record up to 700 milliseconds of data before the Deployment criteria is met and 290 milliseconds after the Deployment criteria is met.
-Time between events is recorded in 10 msec intervals and is displayed in seconds for a maximum time of 655.33 seconds. The counter measures the time from the start of one event to the start of the next event, if both events occur within the same ignition cycle.
-The Maximum SDM Recorded Vehicle Velocity Change may occur between the recorded 10 millisecond sample points of the SDM Recorded Vehicle Velocity Change.
-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 or the commanded state of the brake lamps.
-Pre-Crash data is recorded asynchronously. The 0.5 second Pre-crash data value (most recent recorded data point) is the data point last sampled before Time Zero. That is to say, the last data point may have been captured just before Time Zero but no more than 0.5 second before Time Zero. All subsequent Pre-crash data values are referenced from this data point.
-Pre-Crash Electronic Data Validity Check Status indicates “Data Invalid” if:
-The SDM receives a message with an “invalid” flag from the module sending the pre-crash data
-Pre-Crash Electronic Data Validity Check Status indicates “Data Not Available” if:
-No data is received from the module sending the pre-crash data
-For diesel powered vehicles, the data displayed as Throttle Position (%) is actually the data for the Air Inlet Flap Position. Thisis 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 Counters tracks the number of Deployment events that have occurred during the SDM’s lifetime.
-Dynamic Event Counters tracks the number of qualified events (either Deployments, Non-deploy, or Rollover events) that have occurred during the SDM’s lifetime.
-For Deployment Events, DTC B0052 (Deployment commanded) shall be recorded with the remainder of the data for this event even though it occurred after Event Enable.
-Once a firing loop has been commanded to be deployed, it will not be commanded to be deployed again during the same ignition cycle. Firing loop times for subsequent deployment type events, during the same ignition cycle, will record the deployment times as N/A.
-The GM parameter name is displayed in parentheses after the NHTSA Part 563 parameter name.
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

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

Data Element Sign Convention:
The following table provides an explanation of the sign notation for data elements that may be included in this CDR report. Directional references to sign notation are all from the perspective of the driver when seated in the vehicle facing the direction of forward vehicle travel.

Data Element Name	Positive Sign Notation Indicates
Longitudinal Acceleration	Forward
Longitudinal Velocity Change	Forward
Lateral Acceleration	Left to Right
Lateral Velocity Change	Left to Right
Vertical Acceleration	Downward
Roll Rate	Clockwise Rotation

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

01058_SDM40-conti_r005

System Status at Time of Retrieval

Dynamic Deployment Event Counter	1
Multi-Event, Number of Events (Dynamic Event Counter)	1
Dynamic OnStar Notification Event Counter	1
Driver Frontal Stage 2 Commanded after Event End for Event Record #1	No
Passenger Frontal Stage 2 Commanded after Event End for Event Record #1	No
Driver Frontal Stage 2 Commanded after Event End for Event Record #2	No
Passenger Frontal Stage 2 Commanded after Event End for Event Record #2	No
Driver Frontal Stage 2 Commanded after Event End for Event Record #3	No
Passenger Frontal Stage 2 Commanded after Event End for Event Record #3	No
Longitudinal Accelerometer Range (g)	100
Lateral Accelerometer Range (g)	100
Dynamic PedPro Deploy Event Counter	0
Dynamic PedPro Event Counter	0
Vehicle Identification Number (VIN)	1G1ZB5ST6GF******
System Type	N/A
Ignition Cycle, Download (Ignition Cycles at Investigation)	1,720

System Status at Event (Record 1)

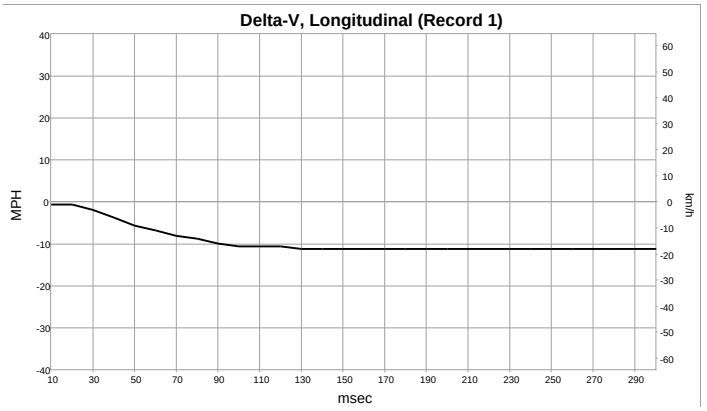
Complete File Recorded (Event Recording Complete)	Yes
Event Record Type	Deployment
Crash Record Locked	Yes
OnStar Deployment Status Data Sent	Yes
OnStar SDM Recorded Vehicle Velocity Change Data Sent	Yes
High Voltage Disable Notification Sent	Yes
Deployment Commanded in Energy Reserve Mode	No
Deployment Event Counter	1
Multi-Event, Number of Events (Event Counter)	1
OnStar Notification Event Counter	1
Algorithms Active - Frontal	Yes
Algorithms Active - Side	Yes
Algorithms Active - Rollover	No
Algorithms Active - Rear	Yes
Ignition Cycle, Crash (Ignition Cycles at Event)	1,719
Time From Event 1 to 2 (Time Between Events) (msec)	Data Not Available
Concurrent Event Flag Set	No
Event Severity Status: Frontal Pretensioner	Yes
Event Severity Status: Frontal Stage 1	Yes
Event Severity Status: Frontal Stage 2	Yes
Event Severity Status: Left Side	No
Event Severity Status: Right Side	Yes
Event Severity Status: Rear	No
Event Severity Status: Rollover	No
Event Severity Status: Battery Disconnect Switch - Side Event	No
Safety Belt Status, Driver (Driver Belt Switch Circuit Status)	Buckled
Safety Belt Status, Right Front Passenger (Passenger Belt Switch Circuit Status)	Buckled
Center Front Row Belt Switch Circuit Status (If Equipped)	Data Not Available
Center Row 3 Belt Switch Circuit Status (If Equipped)	Data Not Available
Passenger Seat Occupancy Status	Occupied
Occupant Size Right Front Passenger Child (Passenger Classification Status)	No (Small Adult)
Passenger Air Bag ON Indicator Status	On
Passenger Air Bag OFF Indicator Status	Off
Low Tire Pressure Warning Lamp Status 0.5 Seconds prior to Time Zero	Off
Frontal Air Bag Warning Lamp (SIR Warning Lamp Status 0.5 Seconds Prior to Time Zero)	Off
SIR Warning Lamp ON/OFF Time Continuously (seconds)	655,330
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	1,719
Ignition Cycles Since DTCs Were Last Cleared 0.5 Seconds Prior to Time Zero	253
Maximum Delta-V, Longitudinal (Maximum Longitudinal SDM Recorded Vehicle Velocity Change for FSR Event) (MPH [km/h])	-11.2 [-18]
Time, Maximum Delta-V (Time From FSR Time Zero to Maximum Longitudinal SDM Recorded Vehicle Velocity Change) (msec)	176
Maximum Delta-V, Lateral (Maximum Lateral SDM Recorded Vehicle Velocity Change for FSR Event) (MPH [km/h])	-28.0 [-45]
Time Maximum Delta-V, Lateral (Time From FSR Time Zero to Maximum Lateral SDM Recorded Vehicle Velocity Change) (msec)	176
Maximum Resultant Delta-V - Longitudinal for FSR Event (MPH [km/h])	-11.2 [-18]
Maximum Resultant Delta-V - Lateral for FSR Event (MPH [km/h])	-28.0 [-45]
Time from FSR Time Zero to time of the Maximum Resultant Delta-V (msec)	176
Blended Event FSR 1 Severity Type	Frontal (Pretensioner/Stage 1/Stage 2)
Blended Event FSR 2 Severity Type	Side (Left or Right Side)
Blended Event Time from FSR 1 Time Zero to FSR 2 Time Zero (msec)	4
Blended Event FSR 3 Severity Type	Data Not Available
Blended Event Time from FSR 1 Time Zero to FSR 3 Time Zero (msec)	Data Not Available

Diagnostic Trouble Codes 0.5 Seconds Prior to Time Zero (Record 1)

DTC 1	B0052-00
DTC 2	N/A
DTC 3	N/A
DTC 4	N/A
DTC 5	N/A
DTC 6	N/A
DTC 7	N/A
DTC 8	N/A
DTC 9	N/A

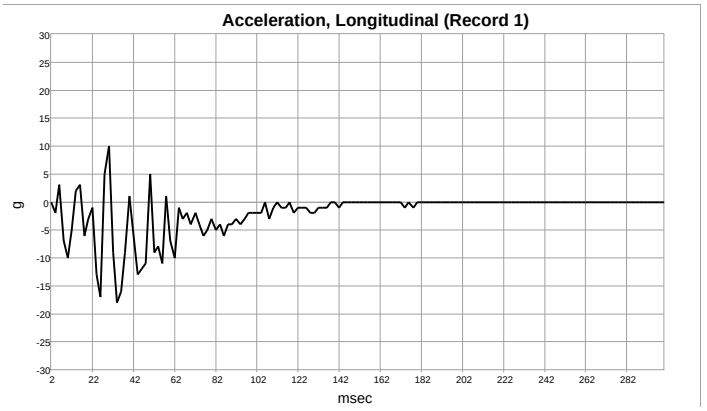
Deployment Command Data (Record 1)

Driver 1st Stage Deployment Loop Commanded	Yes
Passenger 1st Stage Deployment Loop Commanded	Yes
Driver 2nd Stage Deployment Loop Commanded	Yes
Passenger 2nd Stage Deployment Loop Commanded	Yes
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	Yes
Left Row 2 Thorax Loop Commanded	No
Right Row 2 Thorax Loop Commanded	Yes
Left Row 1 Roof Rail/Head Curtain Loop Commanded	Yes
Right Row 1 Roof Rail/Head Curtain Loop Commanded	Yes
Driver Knee Deployment Loop Commanded	Yes
Passenger Knee Deployment Loop Commanded	Yes
Driver Center Inboard Loop Commanded (If Equipped)	No
Frontal Air Bag Deployment, Time to 1st Stage Deployment, Driver (Driver 1st Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	40
Frontal Air Bag Deployment, Time to 1st Stage Deployment, Right Front Passenger (Passenger 1st Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	40
Frontal Air Bag Deployment, Time to 2nd Stage, Driver (Driver 2nd Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	42
Frontal Air Bag Deployment, Time to 2nd Stage, Right Front Passenger (Passenger 2nd Stage Time From Time Zero to Deployment Command Criteria Met) (msec)	45
Pretensioner Deployment, Time to Fire, Driver (Driver Pretensioner Time From Time Zero to Deployment Loop #1 Command Criteria Met) (msec)	33
Pretensioner Deployment, Time to Fire, Right Front Passenger (Passenger Pretensioner Time From Time Zero to Deployment Loop #1 Command Criteria Met) (msec)	33
Pretensioner Deployment, Time to Fire, Driver (Driver Pretensioner Time From Time Zero to Deployment Loop #2 Command Criteria Met) (msec)	38
Pretensioner Deployment, Time to Fire, Right Front Passenger (Passenger Pretensioner Time From Time Zero to Deployment Loop #2 Command Criteria Met) (msec)	38
Side Air Bag Deployment, Time to Deploy, Driver (Driver Thorax Time From Time Zero to Deployment Command Criteria Met) (msec)	Data Not Available
Side Air Bag Deployment, Time to Deploy, Right Front Passenger (Passenger Thorax Time From Time Zero to Deployment Command Criteria Met) (msec)	44
Left Row 2 Thorax Time From Time Zero to Deployment Command Criteria Met (msec)	Data Not Available
Right Row 2 Thorax Time From Time Zero to Deployment Command Criteria Met (msec)	44
Left Row 1 Curtain Time From Time Zero to Deployment Command Criteria Met (msec)	40
Right Row 1 Curtain Time From Time Zero to Deployment Command Criteria Met (msec)	40
Driver Knee Time From Time Zero to Deployment Command Criteria Met (msec)	40
Passenger Knee Time From Time Zero to Deployment Command Criteria Met (msec)	40
Driver Center Inboard Time From Time Zero to Deployment Loop Command Criteria Met (If Equipped) (msec)	Data Not Available


Delta-V, Longitudinal (Record 1)
MPH
km/h
msec
40
30
20
10
0
-10
-20
-30
-40
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
10
30
50
70
90
110
130
150
170
190
210
230
250
270
290

Longitudinal Delta-V (Record 1)

Time (msec)	Delta-V, Longitudinal (SDM Recorded Vehicle Longitudinal Velocity Change for FSR Event) (MPH [km/h])
10	-0.6 [-1]
20	-0.6 [-1]
30	-1.9 [-3]
40	-3.7 [-6]
50	-5.6 [-9]
60	-6.8 [-11]
70	-8.1 [-13]
80	-8.7 [-14]
90	-9.9 [-16]
100	-10.6 [-17]
110	-10.6 [-17]
120	-10.6 [-17]
130	-11.2 [-18]
140	-11.2 [-18]
150	-11.2 [-18]
160	-11.2 [-18]
170	-11.2 [-18]
180	-11.2 [-18]
190	-11.2 [-18]
200	-11.2 [-18]
210	-11.2 [-18]
220	-11.2 [-18]
230	-11.2 [-18]
240	-11.2 [-18]
250	-11.2 [-18]
260	-11.2 [-18]
270	-11.2 [-18]
280	-11.2 [-18]
290	-11.2 [-18]
300	-11.2 [-18]

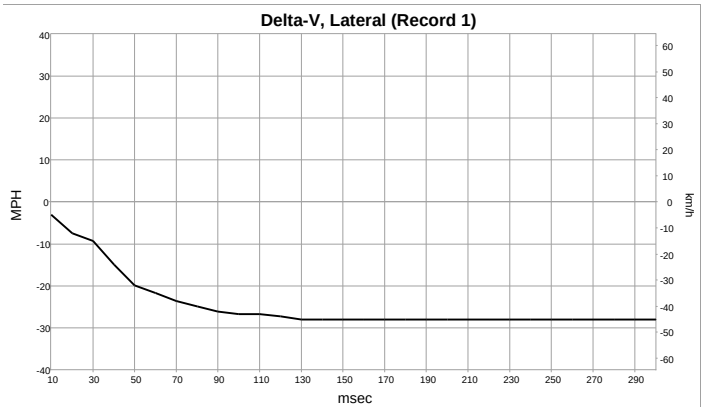

Acceleration, Longitudinal (Record 1)
g
msec
30
25
20
15
10
5
0
-5
-10
-15
-20
-25
-30
2
22
42
62
82
102
122
142
162
182
202
222
242
262
282

Longitudinal Acceleration (Record 1)

Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event)
2	0
4	-2
6	3
8	-7
10	-10
12	-5
14	2
16	3
18	-6
20	-3
22	-1
24	-13
26	-17
28	5
30	10
32	-9
34	-18
36	-16
38	-9
40	1
42	-6
44	-13
46	-12
48	-11
50	5
52	-9
54	-8
56	-11
58	1
60	-7
62	-10
64	-1
66	-3
68	-2
70	-4
72	-2
74	-4
76	-6
78	-5
80	-3
82	-5
84	-4
86	-6
88	-4
90	-4
92	-3
94	-4
96	-3
98	-2
100	-2
102	-2
104	-2
106	0
108	-3
110	-1
112	0
114	-1

Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event)
116	-1
118	0
120	-2
122	-1
124	-1
126	-1
128	-2
130	-2
132	-1
134	-1
136	-1
138	0
140	0
142	-1
144	0
146	0
148	0
150	0
152	0
154	0
156	0
158	0
160	0
162	0
164	0
166	0
168	0
170	0
172	0
174	-1
176	0
178	-1
180	0
182	0
184	0
186	0
188	0
190	0
192	0
194	0
196	0
198	0
200	0
202	0
204	0
206	0
208	0
210	0
212	0
214	0
216	0
218	0
220	0
222	0
224	0
226	0
228	0
230	0

Time (msec)	Longitudinal Acceleration (SDM Recorded Vehicle Longitudinal Acceleration for FSR Event)
232	0
234	0
236	0
238	0
240	0
242	0
244	0
246	0
248	0
250	0
252	0
254	0
256	0
258	0
260	0
262	0
264	0
266	0
268	0
270	0
272	0
274	0
276	0
278	0
280	0
282	0
284	0
286	0
288	0
290	0
292	0
294	0
296	0
298	0
300	0


Delta-V, Lateral (Record 1)
MPH
km/h
msec
40
30
20
10
0
-10
-20
-30
-40
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
10
30
50
70
90
110
130
150
170
190
210
230
250
270
290

Lateral Delta-V (Record 1)

Time (msec)	Delta-V, Lateral (SDM Recorded Vehicle Lateral Velocity Change for FSR Event) (MPH [km/h])
10	-3.1 [-5]
20	-7.5 [-12]
30	-9.3 [-15]
40	-14.9 [-24]
50	-19.9 [-32]
60	-21.7 [-35]
70	-23.6 [-38]
80	-24.9 [-40]
90	-26.1 [-42]
100	-26.7 [-43]
110	-26.7 [-43]
120	-27.3 [-44]
130	-28.0 [-45]
140	-28.0 [-45]
150	-28.0 [-45]
160	-28.0 [-45]
170	-28.0 [-45]
180	-28.0 [-45]
190	-28.0 [-45]
200	-28.0 [-45]
210	-28.0 [-45]
220	-28.0 [-45]
230	-28.0 [-45]
240	-28.0 [-45]
250	-28.0 [-45]
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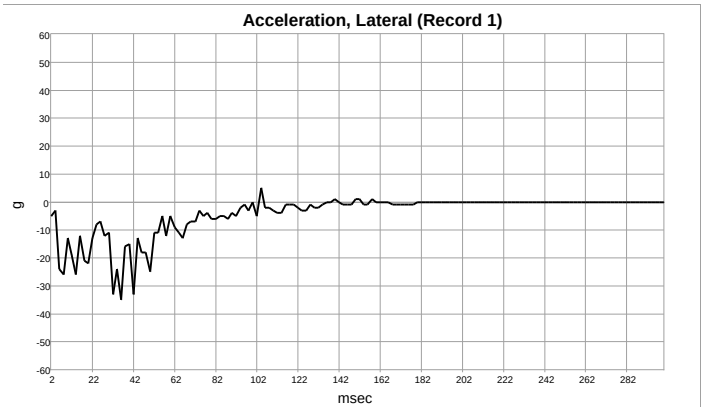
270	-28.0 [-45]
280	-28.0 [-45]
290	-28.0 [-45]
300	-28.0 [-45]


Acceleration, Lateral (Record 1)
g
60
50
40
30
20
10
0
-10
-20
-30
-40
-50
-60
2
22
42
62
82
102
122
142
162
182
202
222
242
262
282
msec

Lateral Acceleration (Record 1)

Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)
2	-5
4	-3
6	-24
8	-26
10	-13
12	-19
14	-26
16	-12
18	-21
20	-22
22	-13
24	-8
26	-7
28	-12
30	-11
32	-33
34	-24
36	-35
38	-16
40	-15
42	-33
44	-13
46	-18
48	-18
50	-25
52	-11
54	-11
56	-5
58	-12
60	-5
62	-9
64	-11
66	-13
68	-8
70	-7
72	-7
74	-3
76	-5
78	-4
80	-6
82	-6
84	-5
86	-5
88	-6
90	-4
92	-5
94	-2
96	-1
98	-3
100	0
102	-5
104	5
106	-2
108	-2
110	-3
112	-4
114	-4

Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)
116	-1
118	-1
120	-1
122	-2
124	-3
126	-3
128	-1
130	-2
132	-2
134	-1
136	0
138	0
140	1
142	0
144	-1
146	-1
148	-1
150	1
152	1
154	-1
156	-1
158	1
160	0
162	0
164	0
166	0
168	-1
170	-1
172	-1
174	-1
176	-1
178	-1
180	0
182	0
184	0
186	0
188	0
190	0
192	0
194	0
196	0
198	0
200	0
202	0
204	0
206	0
208	0
210	0
212	0
214	0
216	0
218	0
220	0
222	0
224	0
226	0
228	0
230	0

Time (msec)	Lateral Acceleration (SDM Recorded Vehicle Lateral Acceleration for FSR Event) (g)
232	0
234	0
236	0
238	0
240	0
242	0
244	0
246	0
248	0
250	0
252	0
254	0
256	0
258	0
260	0
262	0
264	0
266	0
268	0
270	0
272	0
274	0
276	0
278	0
280	0
282	0
284	0
286	0
288	0
290	0
292	0
294	0
296	0
298	0
300	0

Roll Rate (Record 1)

Contains No Recorded Data

Acceleration, Lateral, Rollover (Record 1)

Contains No Recorded Data

Acceleration, Normal, Rollover (Record 1)

Contains No Recorded Data

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

Time (sec)	Accelerator Pedal Position, % Full (Accelerator Pedal Position) (%)	Service Brake (Brake Switch Circuit State)	Engine RPM (Engine Speed) (RPM)	Engine Throttle, % Full (Throttle Position) (%)	Speed, Vehicle Indicated (Vehicle Speed) (MPH [km/h])
-5.0	0	On	960	23	5.0 [8]
-4.5	0	On	896	23	3.7 [6]
-4.0	0	On	832	23	1.2 [2]
-3.5	0	On	832	23	0.0 [0]
-3.0	0	Off	832	22	0.0 [0]
-2.5	27	Off	1,472	57	1.2 [2]
-2.0	27	Off	1,920	78	4.3 [7]
-1.5	32	Off	2,240	70	7.5 [12]
-1.0	32	Off	2,496	58	11.2 [18]
-0.5	32	Off	3,008	53	14.3 [23]

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

Time (sec)	Cruise Control Resume Switch Active	Cruise Control Active	Cruise Control Set Switch Active	Reduced Engine Power Mode Indicator	Engine Torque (N-m)
-2.0	No	No	No	Off	110
-1.5	No	No	No	Off	134
-1.0	No	No	No	Off	148
-0.5	No	No	No	Off	138

Hexadecimal Data

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15	01 02 03 04 05 06 07
16	08 09 0A 0D 0E 13 14
17	00 00 0B 0C 00 00 00
1F	01 01 02 02 00 00 00
20	00 00 00 00 00 00 00
30	00 FF 00 00 00 00 00
32	00 FD 06 B8 00 00 00
51	0B 00 00

DID	Data
01	41 55 33 33 35 35 54 30 30 30 30 47 4D 54 30 41
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05	41 48 33 36 37 36 54 31 35 57 54 39 31 38 31 33
06	0E 05 02 01
07	41 4A 33 36 37 36 54 31 35 47 53 50 53 48 33 34
08	0E 05 02 01
09	44 41 33 36 37 36 54 31 35 57 34 41 36 48 32 39
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0B	44 42 33 36 37 36 54 31 35 47 53 39 4D 4E 33 4A
0C	0E 05 02 01
0D	30 30 30 30 30 30 54 30 30 30 30 30 30 30 30 30
0E	00 00 00 00
0F	30 30 30 30 30 30 54 30 30 30 30 30 30 30 30 30
10	00 00 00 00
11	00 00
22	82 14
30	01 00 01 01 00 64 64 00 00 00
31	A5 F8 01 00 01 01 0B 06 B7 FF FF 00 00 00 17 FF 5C 30 00 00 00 5C FC FC F0 20 60 F0 4C 20 20 20

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75 81 C1 7B 4F 83 B5 7B B3 7C 7B 73 1B 78 F7 76
9F 79 F1 72 53 7C 7B 79 BF 80 31 7A 23 7D D9 73
4D 7A EB 7A EB 7B 4F 78 F7 7B B3 79 29 81 F3 76
6D 7C 7B 7B E5 7C DF 7B B3 7B B3 7E 3D 80 63 7B
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98      50 43 46 41 53 54 4E 23 34 35

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B3      38 31 32 35 38 36 31 37 30

B4      31 31 31 35 33 31 36 30 30 30 30 31 34 33 38 33

B7      50 AA 12 03 8A

C1      00 CE 27 4A

C2      01 66 B4 F6

C3      01 61 DD 27

CB      00 CE 27 51

CC      00 CF 77 F5
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DOT HS 812 562
August 2018

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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