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The interest in this single-vehicle crash was the crash avoidance technology in a 2016 Mercedes-Benz C450.

16. Abstract

The interest in this single-vehicle crash was the crash avoidance (CA) technology in a 2016 Mercedes-Benz C450. The Mercedes was equipped with a forward collision warning system that included active lane keeping assist, active brake assist and autonomous brake intervention. The on-site investigation was intended to determine what role the CA system may have played in the crash. Active lane keeping assist detects lane markings on the road and warns the driver when the vehicle leaves a lane unintentionally. If the driver does not react to the warning, a lane-correcting application of the brakes can bring the vehicle back into the original lane. Active lane keeping assist is activated in a speed range of 60 to 200 km/h (40 to 120 mph). Based on event data recorder-reported speeds, it would appear likely that the driver received a lane departure warning vibration if other conditions and requirements for system functionality were met. The crash occurred during an early morning in April 2016 on an undivided, two-lane, east/west, county-maintained roadway in California. The Mercedes was being driven westbound at a high rate of speed by a belted 46-year-old male. The other occupant in the vehicle was a belted 30-year-old male seated in the front right position. The crash occurred when the Mercedes departed the roadway on the right edge and struck several trees and a fence located on the roadside. The driver of the Mercedes sustained police-reported "K" (fatal) injuries and was declared deceased on-scene. The front right occupant sustained minor injuries and was transported to a local hospital. The Mercedes was towed due to damage, released, and sold by the insurance company in August 2016.

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SCI Case Number DS16012
Vehicle: 2016 Mercedes-Benz C450
Location: California
Crash Date: April 2016

BACKGROUND

The interest in this single-vehicle crash was the crash avoidance (CA) technology in a 2016 Mercedes-Benz C450 (**Figure 1**). The Mercedes was equipped with a forward collision warning system that included active lane keeping assist, active brake assist, and autonomous brake intervention. The on-site investigation was intended to determine what role the CA system may have played in the crash. This investigation was initiated by the Special Crash Investigations (SCI) group of the National Highway Traffic Safety Administration on April 21, 2016 following a notification from Dynamic Science, Inc. The crash was initially identified in an online news article. The police report face page was obtained and the vehicle inspection was completed on May 11, 2016. The Mercedes was supported by the Bosch crash data retrieval (CDR) system and the vehicle's event data recorder (EDR) was imaged during the inspection. The EDR report did not include any CA or steering angle data. Additionally, the EDR pre-crash data tables do not indicate any slowing of the vehicle prior to the first two events of the crash which may otherwise have been an indicator of autonomous braking. Pre-crash deceleration of vehicle speed as indicated in the EDR report in Event 3 appeared to be impact-related and not CA-related.

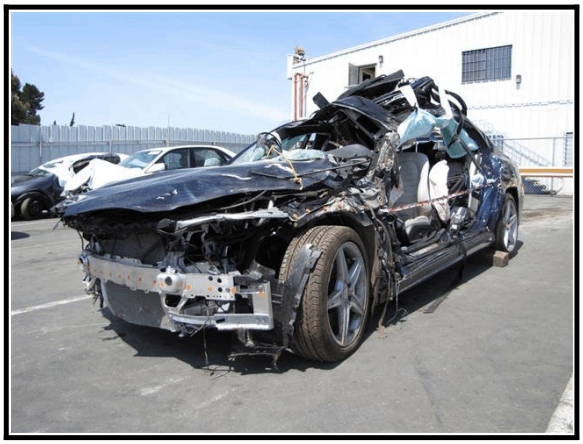

Figure 1. 2016 Mercedes-Benz C450

CA technology in the Mercedes included an Active Lane keeping assist feature that monitors the area in front of the vehicle by means of a camera at the top of the windshield. Active lane keeping assist detects lane markings on the road and warns the driver when a front tire crosses a lane marking unintentionally. The system is designed to give a haptic warning in the form of steering wheel vibration. If the driver does not react to the warning, a lane-correcting application of the brakes controlled by the system can bring the vehicle back into the original lane. According to the vehicle operator's manual "Driving systems" section, active lane keeping assist is activated in a speed range of 60 to 200 km/h (40 to 120 mph). Based on EDR reported speeds, it would appear likely that the driver received a lane departure warning if other conditions and requirements for system functionality were met. Based on the EDR pre-crash data, it was determined the vehicle departed the roadway traveling at an estimated speed of 149.0 km/h (93.0 mph). According to the vehicle operator's manual, the system may be impaired or may not function under several conditions, and the system will not continuously return a vehicle to its original lane. The system may be overridden by other conditions, including driver input and environmental factors. These variables are discussed in greater detail in the Crash Site, Pre-Crash, and Crash Avoidance Technology sections of this report.

The crash occurred during an early morning in April 2016 on an undivided, two-lane, east/west, county-maintained roadway in California. The Mercedes was being driven westbound at an EDR-reported maximum speed of 152 km/h (94 mph) by a belted 46-year-old male. The only other occupant in the vehicle was a belted 30-year-old male seated in the front right position. The crash occurred when the Mercedes departed the roadway on the right edge and struck several trees and a fence located on the roadside. It is likely the crash occurred in part due to the driver's intoxicated state, a vehicle speed too excessive for conditions, and, according to the front right occupant in his statement to police, loss of control caused as the driver attempted to demonstrate the vehicle's attributes to the front right occupant. Lane keeping assist is not intended to compensate for loss of control. The driver's toxicology report and the coroner report indicated that he was severely intoxicated. The front right passenger stated to police that the driver was trying to "show off" by driving fast.

The Mercedes was equipped with driver's and passenger's frontal air bags for the front row, seat-mounted side impact air bags for the four outboard seat positions, combination roll-sensing/side impact inflatable curtain (IC) air bags for both rows, and a knee air bag for the driver. During the crash, both frontal air bags, both IC air bags, the driver's seat-mounted air bag and knee air bag, and the second row left seat-mounted side air bag deployed.

The driver of the Mercedes sustained police-reported "K" (fatal) injuries and was declared deceased on-scene. The front right occupant sustained minor (non-police reported) injuries and was transported to a local hospital. The vehicle was towed due to damage and was later transferred to an auction lot and sold.

SUMMARY

Crash Site

The crash site was a two-lane east/west county-maintained roadway situated in a rural area in California (**Figure 2**). The roadway configuration included one lane for each direction of travel. Each lane measured 3.3 m (10.8 ft) in width and the roadway measured 6.6 m (21.6 ft) in total width. The lanes were separated by a double yellow painted stripe, and were bordered on each side by solid white painted fog lines. The painted stripes appeared to be old, worn, chipped, and cracked in some areas, but were still clearly visible and continuous without interruption or gaps. According to the "Driving systems" section in the operator's manual, the vehicle's lane keeping assist system can be impaired or may not function if lane markings are worn away or not clearly defined and sufficiently visible. The manual also states the system may be impaired or may not function if the lane or roadway is narrow and winding, but it does not define the parameters for such conditions.

Figure 2. Crash site looking west

The roadside was configured with narrow paved shoulders measuring 0.4 m (1.3 ft) in width, and drainage ditches measuring approximately 0.5 m (1.6 ft) in depth. Adjacent to the paved shoulder and ditch on the right (north) edge, the roadside was configured with unpaved ground, mature trees, and high grass. A barbed wire fence was located 6.6 m (21.6 ft) north of the roadway, delineating county-maintained land from privately owned property which was a generally level field configured with scattered mature trees.

When traveling westbound, this roadway curved left in a radius measuring 157.0 m (515.0 ft) from the north fog line. The calculated critical speed of the curve is 118.8 km/h (73.8 mph), or approximately 32 km/h (20 mph) less than the EDR-reported pre-crash vehicle speed of the Mercedes. Facing west within the curved section, the slope measured negative 3.5 percent and the super-elevation measured positive 5.3 percent. The roadway was paved with asphalt in reasonably good condition. It revealed chips and cracks with vegetation growing between the cracks. The posted speed limit was 56 km/h (35 mph).

Scene evidence documented at the on-site inspection included tire furrow marks on the unpaved roadside, contact damage to two trees, and a recently replaced section of barbed wire fence. The first tire furrow began at the point where the Mercedes crossed the right fog line and departed the roadway on the right edge. The lane departure occurred within a curved section of the road where lane markings were clearly visible with a double yellow painted stripe bordering the left edge and a solid white painted stripe bordering the right edge. The furrow was made by the right side front and rear tires and measured 22.0 m (72.2 ft) in length in a slight counterclockwise arcing pattern. This furrow trajectory indicated the Mercedes' right side tires entered the drainage ditch on the approach to impact. The second furrow began 5.7 m (18.7 ft) west of the end of the first furrow. It measured 3.0 m (9.8 ft) in length and continued to the areas of the first and second tree impacts. The first tree impact (Event 1) was identified by damage to a low overhanging limb measuring 14.0 cm (5.5 in) in diameter. This limb was impacted by the Mercedes' roof and windshield. The second tree impact (Event 2) was identified by damage to a tree trunk measuring 27.0 cm (10.6 in) in width. This tree was contacted by the vehicle's front and left planes. The third area of impact (Event 3) was identified by a recently replaced section of barbed wire fencing including steel posts. Event 4 occurred after the vehicle entered and traveled across an open field. It was reported by the coroner that the vehicle came to rest against a tree in the open field approximately 90 m (300 ft) northwest of where the vehicle departed the roadway and approximately 15 m (50 ft) north of the roadway. The EDR indicated this impact was located on the right plane of the Mercedes. Damage severity for Event 4 was masked by overlapping damage from prior events.

Conditions as reported at the nearest weather station were as follows: temperature 10.0 degrees C (50.0 degrees F), winds west/northwest at 5.6 km/h (3.5 mph), visibility 16.0 km (10.0 mi), and clear skies. Lighting conditions were dark with no overhead illumination present. This was a rural area and no artificial light source was noted during the on-site inspection. The roadway surface was dry and no unusual conditions were present. A crash diagram is included on Page 17 of this report.

Pre-Crash

The Mercedes was traveling westbound at an EDR-reported vehicle speed of 143 km/h (89 mph) at Time Stamp -5.0 seconds. By Time Stamp 0.0 seconds, the vehicle speed had increased to 150 km/h (93 mph). Maximum accelerator pedal percentage during that span was 74 percent at Time Stamp -2.0 seconds, at which time the service brake activation was "Off." The Mercedes departed first the lane and then the roadway on the right edge. The Mercedes travel speed was well above the upper limit of the parameters for the CA system when approaching stationary objects, and it is likely that no forward collision warnings were given prior to impact.

The Mercedes' vehicle operator's manual indicated that, in certain conditions, the lane keeping system may be impaired or may not function. It also states limitations of the system for returning the vehicle to the original travel lane. The manual further states: "If you fail to adapt your driving style, active lane keeping assist can neither reduce the risk of accident nor override the laws of physics. You are responsible for . . . vehicle speed, for braking in good time, and for staying in your lane. Active lane keeping assist cannot continuously keep your vehicle in its lane." In this pre- crash phase of this crash, several factors involving the CA system limitations, driver input, and environmental conditions may have played a role. Active lane keeping assist may be manually activated or deactivated by the driver using a button on the left instrument panel. Damage to the instrument panel precluded inspection of the button at the time of the vehicle inspection, and no occupant interview was obtained, It could not be determined with certainty whether the system was activated or deactivated.

If Active lane keeping assist is activated, the driver may select "Standard" or "Adaptive" settings. Standard mode causes a warning vibration of the steering wheel in a greater variety of conditions, and Adaptive mode causes a warning vibration in fewer conditions. In either setting, the warning vibration occurs *after* a front tire crosses the lane line. If a lane line crossing occurs, a warning vibration will occur earlier if you approach the outer lane marking on a bend or if the system recognizes solid lane markings. Warning vibrations will occur later if the road has narrow lanes. In this crash, the vehicle crossed an outer solid lane marking in a curve on a narrow roadway so it is possible a warning occurred. However, other factors should be considered. In Adaptive mode, warnings are suppressed when a driving safety system intervenes, such as ABS, BAS, or ESP. In this vehicle, the EDR was not configured to report these systems, but the driver did not brake so intervention was unlikely. Warnings are suppressed if the driver initiates a hard acceleration (kickdown) or hard braking. The EDR report indicated that from Time Stamp -3.0 seconds to -0.5 seconds of the pre-crash phase of the first event, accelerator pedal input varied in range from 52-74 percent and vehicle speed increased steadily from 85-94 km/h (136-152 mph). The driver does accelerate toward the end of the pre-crash phase, but the acceleration does not constitute kickdown. This suggests the warning vibration was not suppressed when the vehicle's right front tire crossed the lane marking and departed the roadway.

If no warning vibration occurs, then no lane-correcting brake intervention occurs. If a warning vibration does occur, the system has limited ability to return a vehicle to the original travel lane. It does so by causing braking on the two wheels opposite the side of those which have crossed a

lane marking. In this crash, the system was further limited by driver input and environmental conditions, including the following:

- Vehicle speed. The calculated critical speed of the curve where the departure occurred is 118.8 km/h (73.8 mph), or approximately 32 km/h (20 mph) less than the EDR-reported pre-crash vehicle speed of the Mercedes. The operator's manual states the lane keeping system cannot override the laws of physics.

- Driver input. No lane-correcting brake application occurs if using a sporty driving style with high cornering speeds or high rates of acceleration. This parameter might apply in this crash. The front right occupant's statements to police indicated the driver was driving in an unsafe manner.

- Stability control settings. No brake application occurs if ESP is switched off. During the vehicle inspection, the instrument panel was powered up and two lamps were continuously illuminated, indicating the stability control system was switched off as well as not available due to a malfunction. This evidence regarding the stability control setting is non-conclusive given the damage the vehicle sustained during the crash.

- Lane recognition. Lane-correcting brake application is interrupted automatically if lane markings can no longer be recognized. The departure occurred at high speed on a curve in the dark area. Even if a warning vibration occurred, the system had little time in which to recognize lane markings before the vehicle was completely off road and in a ditch.

The EDR pre-crash data indicated that in the 5.0 seconds prior to algorithm enable (AE), the Mercedes was traveling at high speed in a range of 136 to 152 km/h (85 to 94 mph) with an accelerator pedal actuation range of 0-74 percent and a service brake activation "Off," the one exception occurring at Time Stamp -4.0 seconds when service brake activation was "On." In the five seconds preceding AE, the Mercedes traveled a calculated distance of 196.1 m (643.4 ft). Scene evidence included the tire marks at the area of roadway departure, and this data was used to calculate the time and distance traveled beginning at the area of departure and ending at the area of impact (AE for Event 1). The time lapse between the two points was 0.8 seconds and the distance was 35.3 m (115.8 ft).

The EDR-reported pre-crash vehicle speed was used to calculate incremental and cumulative distances traveled in 0.5-second intervals as follows:

Time Stamp (seconds)	Vehicle Speed km/h (mph)	Incremental Distance Traveled m (ft)	Cumulative Distance Traveled m (ft)
-5.0	143 (89)	NA	NA
-4.5	141 (88)	19.7 (64.7)	19.7 (64.7)
-4.0	139 (86)	19.4 (63.8)	39.1 (128.3)
-3.5	137 (85)	19.1 (62.7)	58.2 (191.0)
-3.0	136 (85)	19.0 (62.3)	77.2 (253.3)
-2.5	138 (86)	18.9 (62.0)	96.1 (315.3)
-2.0	141 (88)	19.1 (62.8)	115.2 (378.0)
-1.5	145 (90)	19.3 (63.3)	134.5 (441.3)
-1.0	149 (93)	20.1 (66.1)	154.6 (507.3)
-0.5	152 (94)	20.4 (66.9)	175.0 (574.2)
0.0	150 (93)	21.1 (69.2)	196.1 (643.4)

Crash

The crash included four events. Prior to impact, the vehicle's supplemental restraint system (SRS) commanded a non-collision deployment of the IC air bags and actuation of the front row seat belt pretensioners. The non-collision deployments were likely triggered by the vehicle traveling in a counterclockwise yaw within the drainage ditch. The vehicle's EDR reported a rollover event type with deployments at 117 milliseconds (msec) following AE. The deployments occurred 254 ms and 10.5 m (34.6 ft) prior to the first impact. The report stated a maximum longitudinal delta-V of -8.1 mph (-13.0 km/h) at 300 msec and a maximum lateral delta-V of -7.5 mph (-12.0 km/h) at 285 msec. The EDR-reported vehicle speed at Time Stamp 0.0 seconds was 150 km/h (93 mph).

Event 1 was a tree impact in which the top plane of the Mercedes impacted a low overhanging tree limb. Contact to the roof structure began on the right aspect, beginning at the windshield header and extending rearward to the backlight header. The damage included the fracturing of the panoramic moon roof glazing. The damage pattern was a swiping type configuration that precluded a WinSMASH reconstruction of this event.

Event 2, another tree impact, immediately followed Event 1 and the front plane of the Mercedes impacted a tree trunk (**Figure 3**). This was a narrow left corner engagement which continued down the left plane of the vehicle.

Figure 3. Area of impact Event 2, damaged tree, looking northwest on roadside

Damage to the tree began 20.0 cm (7.8 in) above ground and extended upward ending at 140.0 cm (55.1 in) above ground. For the Mercedes in Event 2, the barrier algorithm of the WinSMASH program calculated a total delta-V of 13.0 km/h (8.0 mph), a longitudinal delta-V of -13.0 km/h (-8.0 mph), a lateral delta-V of 0 km/h, and a barrier equivalent speed (BES) of 13.0 km/h (8.0 mph). The WinSMASH results are considered borderline. The vehicle's EDR likely reported Event 1 and Event 2 as a single event (see EDR report, Record 2). The EDR record identified a frontal event type with deployments in which both frontal air bags deployed in two stages at 271 msec and 276 msec, respectively. Additionally, both pretensioners actuated at 278 msec, the driver's seat-mounted side air bag deployed at 315 msec and the passenger's frontal air bag third stage (vent) deployed at 349 msec. The Mercedes' EDR reported a maximum longitudinal delta-V of -18.0 km/h (-11.2 mph) and a maximum lateral delta- V of 7.0 km/h (4.3 mph). The EDR-reported vehicle speed at Time Stamp 0.0 seconds was 150 km/h (93 mph). EDR reported time from previous event (rollover) to current event (frontal) was 373 msec and the calculated distance traveled between events was 15.5 m (50.9 ft). Following Event 2, the Mercedes rotated counterclockwise and continued traveling at a relatively high speed.

Event 3 was a right plane impact with a barbed wire fence. The Mercedes struck the fence broadside right side leading and continued traveling off-road through an open field. This impact was not captured by the EDR, probably due to a low delta-V. The Mercedes then traveled into the field and impacted another object, probably a tree, which the EDR identified as a side event type non-deployment event, as reported by the EDR. The maximum longitudinal delta-V was -3.0 km/h (-1.9 mph) at 298 msec and the maximum lateral delta-V was -15.0 km/h (-9.3 mph). The reported delta- V sign conventions indicate this was a right side (right to left) impact. The first indication of active braking appears at Time Stamp -0.5 seconds in the EDR pre-crash data. The service brake activation is "On," but the accelerator pedal is at 100 percent and the vehicle speed is 128 km/h (80 mph). At Time Stamp 0.0 seconds, the service brake is "On," accelerator pedal is 0 percent, and vehicle speed was 111 km/h (69 mph). EDR reported time from previous event (frontal) to current event (side) was 1,160 msec, and the Mercedes traveled a calculated distance of 38.7 m (127.0 ft) between events.

The vehicle continued traveling an unknown distance across a field. It initiated a clockwise rotation and impacted a tree (Event 4), which the EDR captured as a right side event occurring 1.16 seconds after the preceding event. Damage to the vehicle was overlapping with prior damage and was not given a separate CDC. The vehicle came to rest with its front right bumper corner in contact with the tree.

Post-Crash
Following the crash, the driver was presumably deceased given the severity of his head injury and his unresponsiveness to the front right occupant's attempts to communicate with him. The front right occupant opened the right side door, exited the vehicle without assistance, and left the scene on foot. Once he reached a public place, he phoned a family member who picked him up in a private vehicle and returned him to the scene to speak with police. Later, this occupant was transported to a local hospital for treatment of minor injuries. Police found the driver in the vehicle with his seat belt buckled around him. He was declared deceased on-scene approximately 5 minutes after the crash and was transported to the coroner's office. The Mercedes was towed due to damage to a police lot, was later released, and eventually sold.

2016 MERCEDES-BENZ C450

Description
The 2016 Mercedes-Benz C450 was identified by the Vehicle Identification Number (VIN): 55SWF6EB5GUxxxxxx. The date of manufacture was May 2015, and the EDR-reported mileage at the time of the crash was 10,590 km (6,580 mi). The Mercedes was a four-door sedan configured with a 6-cylinder 3.0 liter gasoline engine, automatic transmission, all-wheel drive, daytime running lights, and tilt/telescoping steering column functionality. The Mercedes' CA systems included collision warning technology with an antilock braking system (ABS), brake assist system (BAS), "BAS Plus," electronic stability program (ESP), "Pre-Safe Brake," active blind spot assist, and active lane keeping assist. These systems are discussed further in the Crash Avoidance section on Page 11 of this report.

The vehicle manufacturer's recommended tire size was P225/45R18, with a cold tire pressure of 290 kPa (42 psi) for the front and P245/40R18 with a cold tire pressure of 228 kPa (33 psi) for the rear. The vehicle was equipped with Continental Procontact tires of the recommended sizes manufactured during 2015. Specific tire data was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire flat	8 mm (10/32 in)	No	De-beaded
LR	248 kPa (36 psi)	8 mm (10/32 in)	No	None
RR	241 kPa (35 psi)	8 mm (10/32 in)	No	None
RF	Tire flat	8 mm (10/32 in)	No	De-beaded

The Mercedes' interior was equipped with two rows of seating for five occupants. The front row was configured with two bucket seats with adjustable head restraints. Both front row seats tracks were adjusted between middle and full-rearward. The second row was configured with 60/40 split bench seat with folding backs and adjustable head restraints.

Exterior Damage

The crash included four events. Event 1 was a tree impact where the top plane of the Mercedes impacted a low overhanging tree limb. Contact to the top plane began on the right aspect of the roof structure at the right roof side rail and extended laterally 35.0 cm (13.8 in) to the left; it extended longitudinally from the windshield header to the backlight header. The damage included the fracturing and holing of the panoramic moon roof glazing over the first and second rows of seating. Given the area of contact in this impact, it likely fractured the windshield. The damage pattern was a swiping type configuration caused by an overhanging structure, resulting in a moderate damage severity. The collision deformation classification (CDC) for the Mercedes in Event 1 was 12FRGN8.

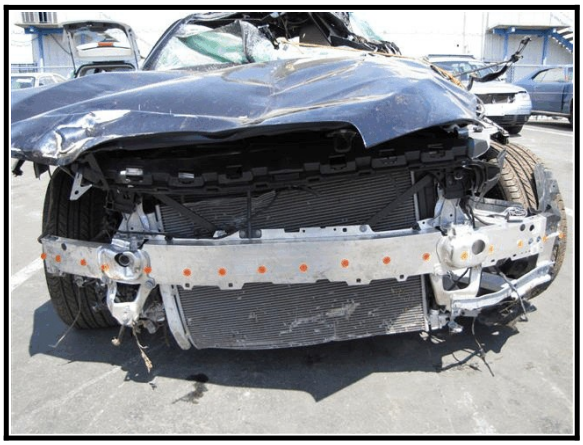

Figure 4. Front bumper crush measurements, 2016 Mercedes-Benz C450

Event 2 was another tree impact where the front plane of the Mercedes impacted a tree trunk. This impact was the most severe of the three events. The event was a narrow left corner engagement which continued down the left plane of the vehicle. The front bumper fascia, left front fender, left B-pillar, and both left side doors were missing from the vehicle at the time of the inspection precluding exact direct damage measurements. However, the front bumper backing bar was crushed, and the damage pattern on the left plane including the left roof side rail, left A-pillar, and left C-pillar suggested that direct damage to the left plane began at or near the front left bumper corner and extended rearward ending 17.0 cm (6.7 in) aft of the left rear axle. The Field L extended from a bumper corner to bumper corner and measured 145.0 cm (57.1 in). Seventeen measurements were taken at bumper level (**Figure 4**) by the Nikon Total Station, and the Faro Blitz program computed crush measurement in six increments as follows: C_1 = 6.0 cm (2.4 in), C_2 = 0 cm, C_3 = 0 cm, C_4 = 2.0 cm (0.8 in), C_5 = 0 cm, C_6 = 2.0 cm (0.8 in). Maximum crush was located at C_1 and the CDC for the Mercedes in Event 2 was 12FLAE9.

Event 3 was a right plane impact with the barbed wire fence. The vehicle was in a counterclockwise rotation with its right side leading at the time of impact. Direct damage to the Mercedes began at the front right bumper corner and extended 449.0 cm (176.8 in), ending at the back right bumper corner. Maximum crush was caused by a steel fence post and was located 15.0 cm (5.9 in) aft of the left front axle, and measuring 13.0 cm (5.1 in). Direct damage consisting of scratches in the sheet metal extended above the beltline to the right B-pillar and C-pillar. The CDC for Event 3 was 02RDAW2.

Event 4 was another tree impact, which was captured by the vehicle's EDR as a right side impact. The damage was masked by prior events, and the estimated CDC for this event was 03RFMN99.

Event Data Recorder

The Mercedes' event data recorder was imaged during the vehicle inspection using the data link connector (DLC) interface with power supplied using jumper cables connected to another vehicle's service battery. The EDR was imaged using Bosch CDR tool version 16.5 and reported using version 17.6.1. The complete EDR report is included in this report as Attachment A.

No CA data was included in the CDR report. The EDR was configured to report system status at event, deployment command data, pre-crash data, and longitudinal and lateral crash pulse. The pre-crash data included Time Stamp in 0.5 second increments for 5.0 seconds, "Vehicle Indicated Speed," "Accelerator Pedal % Full," and "Service Brake Activation." The EDR stored three events. The first two records were deployment events, and the third record was a non-deployment event. The EDR did not report any diagnostic trouble codes (DTC) for the vehicle during the crash. Pre- crash data at Time Stamp 0.0 seconds for each event is included in the table below.

Time (sec) 0.0 at Event	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal (%)	Service Brake Activation
Record 1 (Most Recent)	69 (111)	0	On
Record 2	93 (150)	9	Off
Record 3	93 (150)	9	Off

Interior Damage

The Mercedes' interior revealed damage from impact forces, deployed air bags, actuated seat belt pretensioners, occupant contacts, integrity loss, and post-crash activities. The windshield glazing and roof glazing were fractured and out of place, and the backlight and the second row right side glazing were disintegrated. Six air bags deployed, and both front row seat belt pretensioners actuated during the crash. Occupant contacts were documented on the driver's and front right passenger's seat belts, the driver's frontal air bag, and the left A-pillar. The left side doors were jammed shut. Those two doors and the left B-pillar were removed during post-crash activities. The front and second rows of the occupant compartment were reduced by intrusion. The front row vertical intrusions were documented as follows: left windshield header (15.0 cm [5.9 in]), left roof (10.0 cm [3.9 in]), and middle roof (5.0 cm [2.0 in]). The front row lateral intrusions were documented as follows: left A-pillar (13.0 cm [5.1 in]), left roof side rail (18.0 cm [7.1 in]), and driver's seat back (9.0 cm [3.5 in]). Second row vertical intrusion included the right backlight header (10.0 cm [3.9 in]) and middle backlight header (5.0 cm [2.0 in]). Second row lateral intrusion was located at the right roof side rail (18.0 cm [7.1 in]).

Manual Restraint Systems

The Mercedes' interior was equipped with forward seating for five occupants, and all seats were configured with three-point lap and shoulder seat belts. The front row belts were equipped with retractor pretensioners, sliding latch plates, and adjustable D-rings. Both belt latch plates revealed scratch marks caused by usage. The driver's belt was configured with an emergency locking retractor (ELR). The EDR report stated the driver's belt was buckled, and occupant loading evidence was located at 24.0 cm (9.4 in) above the stop button (**Figure 5**). This belt was cut during post-crash activities, and the left B-pillar with the D-ring assembly was removed and missing.

Figure 6. Driver's seat belt, occupant loading evidence, 2016 Mercedes-Benz C450

The front passenger's belt was configured with a switchable ELR/automatic locking retractor (ALR). The EDR report stated the front right occupant's belt was buckled, and occupant loading evidence was located at 27.0 cm (10.6 in) above the stop button. The D-ring was in the full-down position.

Supplemental Restraint Systems

The Mercedes' supplemental restraint systems (SRS) included nine air bags in the following configuration: driver's and passenger's frontal dual-stage air bags, a knee air bag for the driver, seat-mounted side impact air bags for the front and second row outboard seat positions, and IC air bags for the front and second row outboard seat positions. Seven of the nine available air bags deployed during the crash.

Figure 5. Driver's deployed frontal air bag, 2016 Mercedes-Benz C450

The driver's frontal air bag deployed from a module in the steering wheel hub. The air bag deployed normally without damage to either the air bag or cover flaps. It measured 45.0 cm (17.7 in) in diameter and was configured with two internal tethers and two vent ports located on the back panel. This air bag was soaked with blood deposited by the driver, who sustained a head injury including massive trauma to his skull and brain (**Figure 6**).

The driver's knee air bag deployed from a module in the lower left instrument panel. This air bag was unremarkable except that the module was displaced and hanging from the right fastener only. This damage was likely caused during post-crash activities.

The drivers' seat-mounted side air bag deployed from the driver's seat back. This air bag revealed slight blood deposits from the driver.

The passenger's frontal air bag deployed from a module in the top instrument panel. The air bag deployed normally without damage to either the air bag or cover flaps. This air bag revealed occupant contact evidence in the form of blood. The front panel exhibited a few small holes and tears. It is probable this damage was caused sometime after the crash since the fractured windshield had sagged onto the deployed air bag after the crash.

The second row left seat-mounted side air bag deployed from the left seat-back. It was unremarkable.

Figure 7. Deployed left IC air bag, 2016 Mercedes-Benz CC450

The Mercedes was configured with IC air bags that complied with Federal Motor Vehicle Safety Standard (FMVSS) 226 "Ejection Mitigation," a rule established to reduce the partial and complete ejection of vehicle occupants through side windows in crashes, particularly rollover crashes. Both IC air bags deployed during a non-collision situation when the SRS sensed an impending rollover. The left IC air bag deployed from the roof rail above the front and second rows. It measured 177.0 cm (69.7 in) in width and 37.0 cm (14.6 in) in length. The air bag provided full coverage over the side glass for both rows. In its deflated state, the bottom edge extended to a length 10.0 cm (3.9 in) below the bottom edge of the side glass. This air bag was configured without sail panels or tethers. At the forward aspect, it was connected to the A-pillar beginning at 8.0 cm (3.1 in) above the side glass and continuing upward to the roof side rail (**Figure 7**). The air bag revealed abrasions on the outboard panel caused by contact with the fractured side glass and contact with the impacted tree. This damage appeared to be superficial and did not penetrate the panel. The inboard panel revealed slight blood deposits from the driver.

The right IC air bag deployed from the roof side rail above the front and second rows. It was configured identically to the left IC air bag. This air bag was unremarkable.

Crash Avoidance Technology
The Mercedes was equipped with crash avoidance technology. The systems on this vehicle included the following:

Antilock braking system. ABS regulates brake pressure in such a way that the wheels do not lock when braking.

Brake Assist System. BAS operates in emergency braking situations. If the brake is depressed quickly, BAS automatically boosts the braking force, thus shortening the stopping distance.

BAS Plus. This vehicle was equipped with the Distronic Plus[1] system. With the help of the radar sensor system, BAS Plus can detect obstacles that are in the path of the vehicle for an extended period of time. To avoid a collision, BAS Plus calculates the brake force necessary if approaching an obstacle and BAS Plus has detected a risk of collision. According to the operator's manual:

When driving at a speed under 30 km/h (20 mph): if depressing the brake pedal, BAS Plus is activated. The increase in brake pressure will be carried out at the last possible moment.

When driving at a speed above 30 km/h (20 mph): if depressing the brake pedal sharply, BAS Plus automatically raises the brake pressure to a value adapted to the traffic situation.

BAS Plus provides braking assistance in hazardous situations with vehicles in front within a speed range from 7 km/h (4 mph) to 250 km/h (155 mph).

At speeds of up to approximately 70 km/h (40 mph), BAS Plus can also react to stationary objects. Examples of stationary objects are stopped or parked vehicles.

It is this investigator's opinion that neither BAS nor BAS Plus actuated in response to the impending impacts with the two trees. The vehicle speed was approximately 150 km/h (93 mph) and there was no active driver braking (service brake activation = Off). The EDR's pre-crash data indicates the vehicle was accelerating, not decelerating, prior to impact. Additionally, the first impact involved an overhanging object which may have been out of range for the system's recognition capability. Time between Event 1 and Event 2 was 373 msec, and the Pre-crash data for the two events was identical.

Electronic Stability Program.[2] ESP monitors driving stability and traction, i.e. power transmission between the tires and the road surface. ESP is deactivated when the sport handling mode is selected. The handling mode was not known.

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[1] Distronic Plus is a driver assistance system that combines automatic speed regulation with proximity control in relation to a vehicle traveling in front.

[2] Mercedes-Benz name for its ESC. Mitigates loss of control by applying braking force at wheels to help the driver steer the vehicle.

Pre-Safe Brake. With the help of the radar sensor system, Pre-safe brake can detect obstacles that are in front of the vehicle for an extended period of time. If Pre-safe brake has detected a risk of collision, the driver will be warned visually and acoustically, as well as by automatic braking. Pre-safe brake cannot prevent a collision without intervention (braking) of the driver. Pre-safe brake will initially brake the vehicle by a partial application of the brakes if a danger of collision is detected. There may be a collision unless the driver brakes. Automatic emergency braking cannot prevent a collision. It is not known if the driver received any collision warnings.

Active Blind Spot Assist. Active blind spot assist uses a radar sensor system to monitor the side areas of the vehicle which are behind the driver. A warning display in the exterior mirrors draws attention to vehicles detected in the monitored area.

Active Lane Keeping Assist. Active lane keeping assist monitors the area in front of the vehicle by means of a camera at the top of the windshield. Active lane keeping assist detects lane markings on the road and warns the driver when the vehicle's front tire crosses a lane marking. If the driver does not react to the warning, a lane-correcting application of the brakes by the system can bring the vehicle back into the original lane in certain conditions. The system is designed to give a haptic warning in the form of steering wheel vibration which may continue for up to 1.5 seconds. Active lane keeping assist is activated in a speed range of 60 to 200 km/h (40 to 120 mph).

Given that the EDR reported speeds within the active lane keeping assist range, it appears likely that the driver could have received a lane departure warning and the vehicle followed with lane-corrective braking. If so, high vehicle speed and the roadway/roadside environment precluded a return to the original travel lane. It is also possible that driver input overrode the system. The driver-selected settings for activating or deactivating the system, and settings for "Standard" or "Adaptive" settings, were not determined. Whether a warning and lane-corrective braking occurred could not be positively determined due to lack of sufficient evidence.

2016 MERCEDES-BENZ C450 OCCUPANTS

Driver Demographics

Age/Sex:	46 years/Male
Height:	175 cm (69 in)
Weight:	68 kg (150 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Middle to rear most
Manual restraint usage:	Lap and shoulder seat belt used
Usage source:	Vehicle inspection, EDR report
Air bags:	Frontal air bag, knee air bag, IC air bag and seat-mounted side impact air bag deployed
Alcohol/Drug data:	Positive for alcohol: BAC 0.21 grams percent
Egress from vehicle:	Removed from vehicle after being declared deceased
Transport from scene:	Ambulance to coroner's office
Type of medical treatment:	None

Driver Injuries

Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Component	IPC Confidence Level
1	Crush injury, head	113000.6	Left A-pillar	Probable

Source: Coroner's report

Driver Kinematics

The belted 46-year-old male driver of the Mercedes was seated in an unknown posture and was negotiating a left curve while operating the vehicle at a high speed. The vehicle departed the roadway on the right edge and traveled onto the roadside. The left IC air bag deployed and the driver's seat belt pretensioner actuated. The vehicle's roof impacted an overhanging tree limb that caused the driver to be displaced forward in response to the direction of force. Immediately following the first impact, the vehicle's front left bumper impacted a second tree causing the driver to be displaced further forward and left. He loaded the seat belt causing scuff marks to the webbing. The left plane of the Mercedes remained in contact with the tree causing lateral intrusion of the left occupant compartment. The tree deformed the left A-pillar, disintegrated the front row left window, and probably entered the window opening. The driver's seat back was displaced 9.0 cm (3.5 in) to the right. The driver's head contacted the intruded left A-pillar causing a crush injury. The coroner's report indicated the driver sustained a massive trauma to the skull, exposing and depositing brain matter within the vehicle. During this impact, the driver's frontal air bag deployed and he deposited blood and body tissue onto it as well as onto the deployed left IC air bag. Following this impact, the vehicle initiated a counterclockwise rotation and impacted a fence with its right plane. The driver was displaced to the right and remained held in his seated position by the pretensioned belt and then the vehicle impacted another tree before coming to rest in the field on the roadside. The driver was pronounced deceased 5 minutes after the crash and was transported to the coroner's office.

First Row Right Occupant Demographics

Age/Sex:	30 years/Male
Height:	185 cm (73 in)
Weight:	84 kg (185 lb)
Eyewear:	Unknown
Seat type:	Bucket seat with adjustable head restraint
Seat track position:	Middle to rear most
Manual restraint usage:	Lap and shoulder seat belt
Usage source:	Vehicle inspection, EDR report
Air bags:	Frontal air bag and IC air bag deployed, seat-mounted side impact air bag did not deploy
Egress from vehicle:	Exited unassisted through front right side door
Transport from scene:	Ambulance to hospital
Type of medical treatment	Treated and released

First Row Right Occupant Injuries

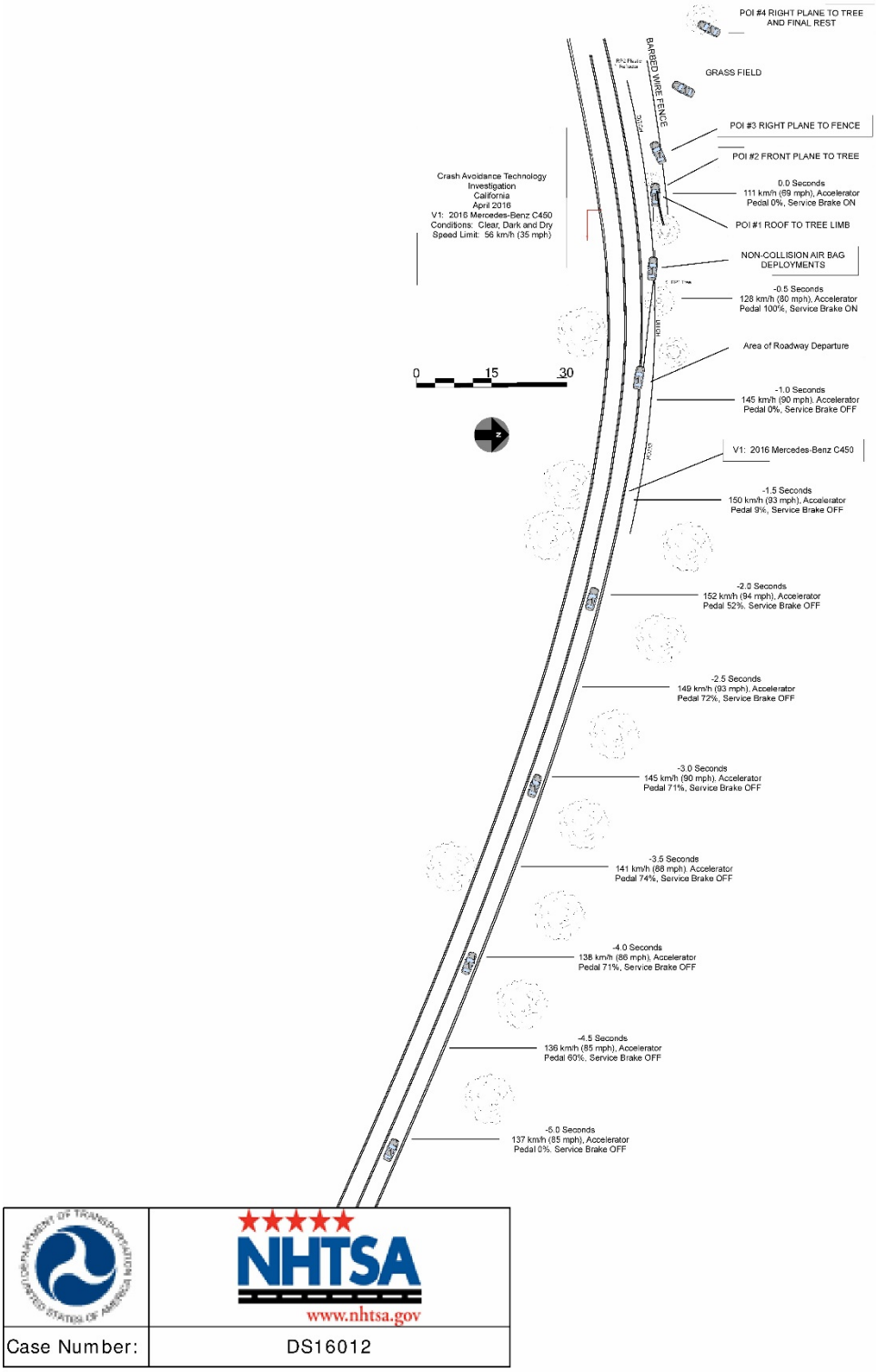
Inj. No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Abrasions, face, forehead	210202.1	Flying glass	Probable
2	Abrasions, face, nose	210202.1	Flying glass	Probable
3	Abrasions, right upper arm	710202.1	Flying glass	Probable
4	Abrasions, left upper arm	710202.1	Flying glass	Probable

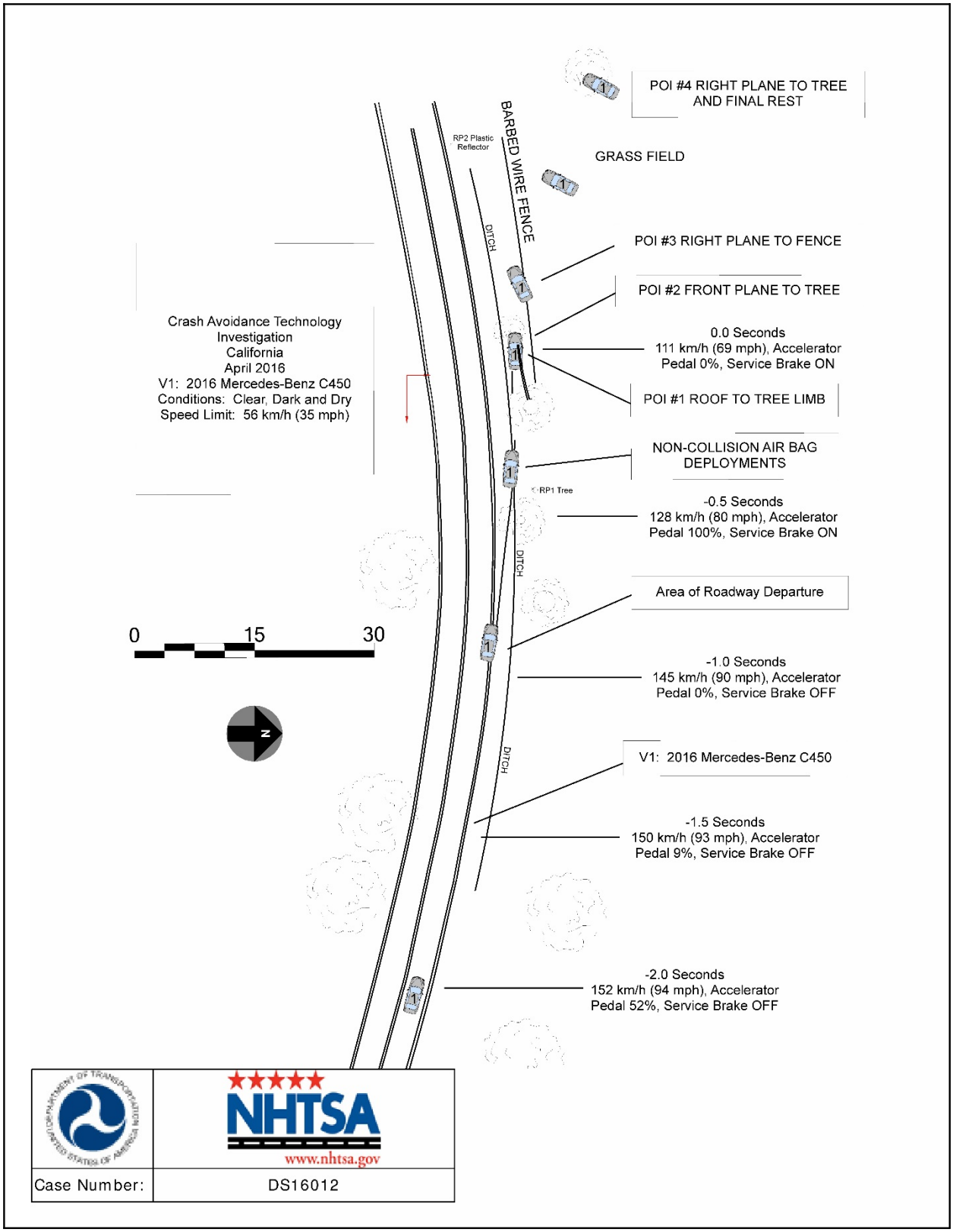
Source: Medical records

First Row Right Occupant Kinematics

The belted 30-year-old male front row right occupant of the Mercedes was seated in an unknown posture. At impact with the overhanging tree limb, he was displaced forward and his head possibly contacted the intruding right roof header and fractured windshield. He may have also raised his arms exposing them to the fractured and flying windshield glazing. The occupant later had glass fragments in his face and upper arms, which caused multiple abrasions to his forehead, nose, face, and bilateral upper arms. The right IC air bag deployed and his seat belt pretensioned during this event. At impact with the second tree, the occupant was displaced forward and left in response to the direction of force, and he was held in place in his seated position by the pretensioned belt. He loaded the seat belt causing scuff marks to the webbing. His frontal air bag deployed during this event and he possibly loaded it with his chest. Following this impact, the vehicle initiated a counterclockwise rotation and impacted a fence with its right plane. The occupant was displaced to the right and possibly loaded the deployed right IC air bag. The occupant remained held in his seated position by the pretensioned belt, and the vehicle impacted another tree before coming to rest in the field on the roadside. The occupant unbuckled his seat belt, opened the right side door, and exited the vehicle unassisted. He fled the crash site on foot and contacted a family member, who later picked up the occupant and returned him to the crash site to speak with police approximately 45 minutes after the crash. Fifteen minutes after arriving back at the scene, the occupant was transported by ambulance to a local hospital located 12.7 km (7.9 mi) away. Transport time was approximately 7 minutes and his Glasgow Coma Score (GCS) was 15. He was treated for minor injuries and discharged 2 hours 40 minutes after arrival.

CRASH DIAGRAM




POI #4 RIGHT PLANE TO TREE AND FINAL REST
GRASS FIELD
BARBED WIRE FENCE
RP2 Plastic Reflector
DITCH
POI #3 RIGHT PLANE TO FENCE
POI #2 FRONT PLANE TO TREE
0.0 Seconds
111 km/h (69 mph), Accelerator Pedal 0%, Service Brake ON
POI #1 ROOF TO TREE LIMB
NON-COLLISION AIR BAG DEPLOYMENTS
RP1 Tree
-0.5 Seconds
128 km/h (80 mph), Accelerator Pedal 100%, Service Brake ON
DITCH
Area of Roadway Departure
Crash Avoidance Technology
Investigation
California
April 2016
V1: 2016 Mercedes-Benz C450
Conditions: Clear, Dark and Dry
Speed Limit: 56 km/h (35 mph)
0
15
30
N
-1.0 Seconds
145 km/h (90 mph), Accelerator Pedal 0%, Service Brake OFF
V1: 2016 Mercedes-Benz C450
DITCH
-1.5 Seconds
150 km/h (93 mph), Accelerator Pedal 9%, Service Brake OFF
-2.0 Seconds
152 km/h (94 mph), Accelerator Pedal 52%, Service Brake OFF
NHTSA
www.nhtsa.gov
Case Number:
DS16012

APPENDIX A:
Event Data Recorder Report 2016 Mercedes-Benz C450

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	55SWF6EB5GU******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	201750S3DS16012_V1_ACM.CDRX
Saved on	
Imaged with CDR version	Crash Data Retrieval Tool 16.5
Reported with CDR version	Crash Data Retrieval Tool 17.6.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type	Airbag Control Module
Event(s) recovered	Record 1 (CRC Check Failed - Saved Without VIN Sequence Number), Record 2 (CRC Check Failed - Saved Without VIN Sequence Number), Record 3 (CRC Check Failed - Saved Without VIN Sequence Number)

Comments

No comments entered.

Data Limitations

MERCEDES-BENZ SUPPLEMENTAL RESTRAINT SYSTEM (SRS) CONTROL MODULE DATA LIMITATIONS:

General Information:
SRS Control Module data limitations are intended to assist in reading event data that has been imaged from the vehicle's SRS control module. They are not intended to provide specific information regarding data interpretation. Event data should be considered in conjunction with other available physical evidence from the vehicle and scene.

Certain MY2014 and later Mercedes-Benz passenger vehicles are designed to fulfill the requirements of 49 CFR 563 - Event Data Recorders, and to be compatible with the Bosch CDR tool.

The Recorded Crash Events can be read by the CDR tool via the vehicle's OBD connector. Connecting the CDR tool directly to the SRS Control Module should ONLY be considered if the vehicle's electrical system has been compromised. If it is necessary to remove the SRS Control Module from the vehicle, proceed with CAUTION! During bench top imaging, make sure the SRS Control Module remains stationary, and is NOT moved, tilted or rotated while connected to and powered by the CDR Interface Module. Also, after CDR imaging, wait at least one minute after power is removed from the SRS Control Module before attempting to move the module. Not following these general SRS Control Module guidelines for bench top imaging could cause new events to be recorded in the Module.
NOTE: When the CDR tool is connected directly to the SRS Control Module, the current fault status will be altered if the Module is powered-up without having all of the other vehicle inputs connected (e.g., benchtop imaging). However, this will not affect the stored fault data information in any of the Event Records.

To increase data safety, the transmitted data will be first signed by the SRS Control Module. This can take up to 60 seconds for each recorded event.

Recorded Crash Events:
Data for front, side, rear, and rollover events can be recorded as either non-deployment or deployment events. Both types of events can contain pre- crash and crash data.

The SRS Control Module can store six events in total, such as Non-Deployment Events (NDE) and Deployment Events (DE):
- A Non-Deployment Event is recorded if the change in longitudinal or lateral velocity equals or exceeds 8km/h over a 150ms timeframe. Non- Deployment Events are stored into memory but (the oldest) can be over-written by subsequent Non-Deployment or Deployment Events.
- A Deployment Event is recorded if any type of non-reversible deployable restraint device (e.g., belt pretensioners, front airbag(s), side airbag (s), side curtain airbag(s), etc.) are commanded to deploy. Deployment Events are stored into memory and cannot be over-written.

The events will be imaged by the CDR tool in chronological order (e.g. the first event is the most recent one).

If power to the SRS Control Module is interrupted during an event, all data from this event will be stored (see information "Complete file recorded"). For subsequent events, all or part of the event data record may not be recorded. Such events cannot be retrieved by the CDR tool.

The "event begin" t_0 is initiated by:
- the change in longitudinal velocity equals or exceeds 0.8km/h over a 20ms timeframe (front threshold)
- the change in lateral velocity equals or exceeds 0.8km/h over a 5ms timeframe (side threshold)
- wake-up of the front, side or rear algorithm
- deployment of a restraint by the rollover algorithm.

The event monitoring for recording will always be 300ms even if:
- the change in longitudinal and lateral velocity equals or falls below 0.8km/h over a 20ms timeframe
- each algorithm is inactive.

Multiple Events:
Data recorded by the SRS Control Module and imaged by the CDR tool is displayed relative to t_0, NOT the time at which the vehicle made contact with another vehicle or object.

Vehicle crash events may result in one or more stored Deployment or Non-Deployment events in the EDR.

Parallel Event: If there are more than one crash algorithms active during an accident, and if the start time for any algorithm occurs within 300ms of t_0 for another algorithm, (e.g. angular impact, where front algorithm and side algorithm starts and resets individually), then these overlapping recordings are considered a "parallel event". In this case, the initial stored event is characterized by one of the following: 1) the first triggered algorithm (e.g., front, side, or rear); 2) the first event threshold which was exceeded (e.g., longitudinal or lateral velocity threshold); or 3) the a deployment of a restraint by the rollover algorithm. Subsequent events are reported with reference to the initial event t_0

Multiple Event: If there are more than one crash algorithms active during an accident and if the algorithms do not overlap as described above, this is considered a "multiple event if t_0 for any algorithm occurs within 5 seconds of t_0 for another algorithms. The chronological sequence within a multiple event is marked by the data element "multi-event, number of events." The time period between this event and the preceding event is marked in the data element "time from event n to n+1."

Separate Events: If there are more than one crash algorithms active during an accident that do not overlap in time and for which start times t_0 are set apart more than 5 seconds, then these are considered as separate events.

Data Element Sign Convention:
The sign convention is according to "NHTSA 49 CFR 563 - Event Data Recorders".

Data Element Name	Positive Sign Notation Indicates
Delta-V, Longitudinal	Forward
Maximum Delta-V, Longitudinal	Forward
Delta-V, Lateral	Left to Right
Maximum Delta-V, Lateral	Left to Right
Vehicle Roll Angle	Clockwise Rotation around vehicles longitudinal axis

Data Elements:
Pre-Crash Data:
- Pre-Crash Data is recorded at 2 samples per second starting 5 seconds before t_0.
- Pre-Crash Data is recorded asynchronously.
- Recorded Pre-Crash Data has a time resolution of 500ms. Therefore, the indicated time associated with the first pre-crash data element may be delayed by up to 500ms.
- Pre-Crash Data indicates "Data Invalid" if a message with an "invalid" flag from the module sending the pre-crash data is sent.
- Pre-Crash Data indicates "Data Not Available" if no data is received from the module sending the pre-crash data.
- "Speed, vehicle indicated" accuracy can be affected by various factors, such as significant changes in tire size from the factory original vehicle specification, wheel lockup or slip.
- "Accelerator Pedal Position, percent full" is the ratio of accelerator pedal position compared to the fully depressed position.
- "Service Brake Status" only indicates driver-initiated braking. Automatic braking (e.g. Autonomous Cruise Control) will not be recorded.

Crash data:
- Delta-V data is recorded at 100Hz from t_0 to 250ms.
- "Delta-V, longitudinal" reflects the change in velocity that the SRS Control Module experienced in the longitudinal direction during the recorded portion of the event and is not the speed at which the vehicle was traveling before the event.
- Depending on the severity of the event relative to the range of the accelerometer, saturation of the SRS Control Module longitudinal or lateral accelerometers may occur. This condition is recorded in the EDR.
- "Restraint Deployment Time" (e.g. airbag(s)) is reported as the time t which a deployment was requested by this device.
- "Restraint Disposal" (e.g. 2nd stage of the frontal airbag(s)) is reported if a disposal request of this device occurs.
- "Seat Track Position Switch Status, front passenger" is reported as "foremost" or "not foremost".
- "Occupant size classification, right front passenger airbag suppressed" data is recorded as "yes" (suppressed), if the front passenger seat sensor system determined the passenger seat was empty or occupied by a child-seat.

Data Source:
All recorded data is measured and calculated within the SRS Control Module except for the following parameters (if applicable) which are transmitted via the vehicle's communication network to the SRS Control Module:
- Speed, vehicle indicated
- Accelerator pedal position, percent full
- Service brake
- Safety Belt Status (the Belt Switch Circuit is wired directly to the SRS Control Module)

Hexadecimal Data:
All data that has been specified for imaging are shown in the hexadecimal data section of this report. However, not all of these data are translated by the CDR tool. The imaged SRS Control Module may contain additional data that are not retrievable by the CDR tool.

Privacy Issue

As of February 2013 the following states: Arkansas, California, Connecticut, Maine, Nevada, New Hampshire, New York, North Dakota, Oregon, Texas, Virginia, and Washington all have EDR Laws to address vehicle owner's privacy and consumer concerns. Subsequently, a 2015 Federal law prescribed privacy restrictions to address these same concerns. It is the responsibility of the user and end user to observe all applicable State and Federal privacy laws.

09001_Daimler001_r004

System Status at Event (Record 1, Most Recent)

Event Type	Side
Time From Time Zero to Frontal Threshold (Beginning of Impact) (msec)	Threshold Not Reached
Time From Time Zero to Side Threshold (Beginning of Impact) (msec)	74
Time From Time Zero to Algo Start (Front) (msec)	8
Time From Time Zero to Algo Start (Side) (msec)	Algorithm Started at t0
Time From Time Zero to Algo Start (Rear) (msec)	4
Time From Time Zero to Deployment (Rollover) (msec)	Algorithm Not Started
Time From Time Zero to Deployment (Pitchover) (msec)	Algorithm Not Started
Time From Time Zero to Algo Start (Pedestrian Protection) (msec)	Algorithm Not Started
Maximum Delta-V, Longitudinal (MPH [km/h])	-1.9 [-3]
Maximum Delta-V, Lateral (MPH [km/h])	-9.3 [-15]
Time, Maximum Delta-V, Longitudinal (msec)	298
Time, Maximum Delta-V, Lateral (msec)	150
Clipping Time Longitudinal Sensor (msec)	Clipping Not Reached
Clipping Time Lateral Sensor (msec)	Clipping Not Reached
Multi-Event, Number of Events	3. Event
Time From Previous Event to Current Event (msec)	1,160
Complete File Recorded, Generic, Prio 1 Data	Completed Successfully
Ignition Cycle, Crash (cycle)	2,663
Ignition Cycle, Download (cycle)	2,665
Vehicle Mileage (km)	10,590
Operating Time (min)	16,122
Vehicle Identification Number	55SWF6EB5GU******
Event Counter (counts)	3

Deployment Command Data (Record 1, Most Recent)

Frontal Air Bag, Time to 1st Stage Deployment, Driver (msec)	Data Not Available
Frontal Air Bag, Time to 2nd Stage Deployment, Driver (msec)	Data Not Available
Frontal Air Bag, Time to 3rd Stage (Vent) Deployment, Driver (msec)	Data Not Available
Frontal Air Bag, 2nd Stage Disposal, Driver	Data Not Available
Frontal Air Bag, 3rd Stage (Vent) Disposal, Driver	Data Not Available
Frontal Air Bag, Time to 1st Stage Deployment, Front Passenger (msec)	Data Not Available
Frontal Air Bag, Time to 2nd Stage Deployment, Front Passenger (msec)	Data Not Available
Frontal Air Bag, Time to 3rd Stage (Vent) Deployment, Front Passenger (msec)	Data Not Available
Frontal Air Bag, 2nd Stage Disposal, Front Passenger	Data Not Available
Frontal Air Bag, 3rd Stage (Vent) Disposal, Front Passenger	Data Not Available
Side Air Bag, Time to Deployment 1st Stage, Driver (msec)	Data Not Available
Side Curtain/Tube Air Bag,Time to Deployment, Driver Side (msec)	Data Not Available
Pretensioner (1), Time to Deploy, Driver (msec)	Data Not Available
Side Air Bag, Time to Deployment 1st Stage, Front Passenger (msec)	Data Not Available
Side Curtain/Tube Air Bag, Time to Deployment, Passenger Side (msec)	Data Not Available
Pretensioner (1), Time to Deploy, Front Passenger (msec)	Data Not Available
Pretensioner (2), Time to Deploy, Driver (msec)	Data Not Available
Pretensioner (2), Time to Deploy, Front Passenger (msec)	Data Not Available
Pretensioner (3), Time to Deploy, Driver (msec)	Data Not Available
Pretensioner (3), Time to Deploy, Front Passenger (msec)	Data Not Available

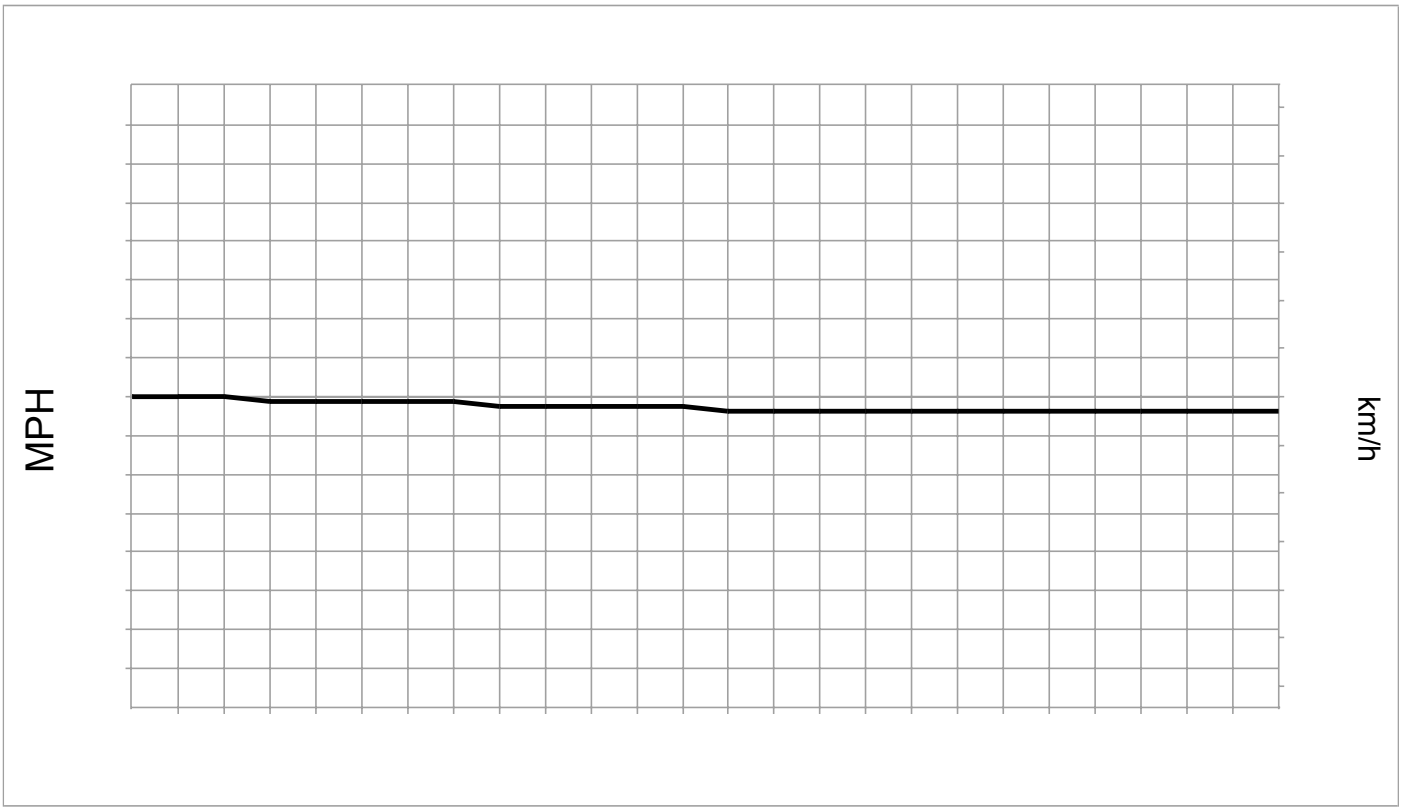
Pre-Crash Data -1 Sec (Record 1, Most Recent)

Safety Belt Status, Driver	Belted
Seat Track Position Switch Status, Driver	Rear
Air Bag Warning Lamp (AWL)	Off
Safety Belt Status, Front Passenger	Belted
Seat Track Position Switch Status, Front Passenger	Rear
Occupant Size Classification, Front Passenger	50% Male

Pre-Crash Data -5 to 0 sec (Record 1, Most Recent)

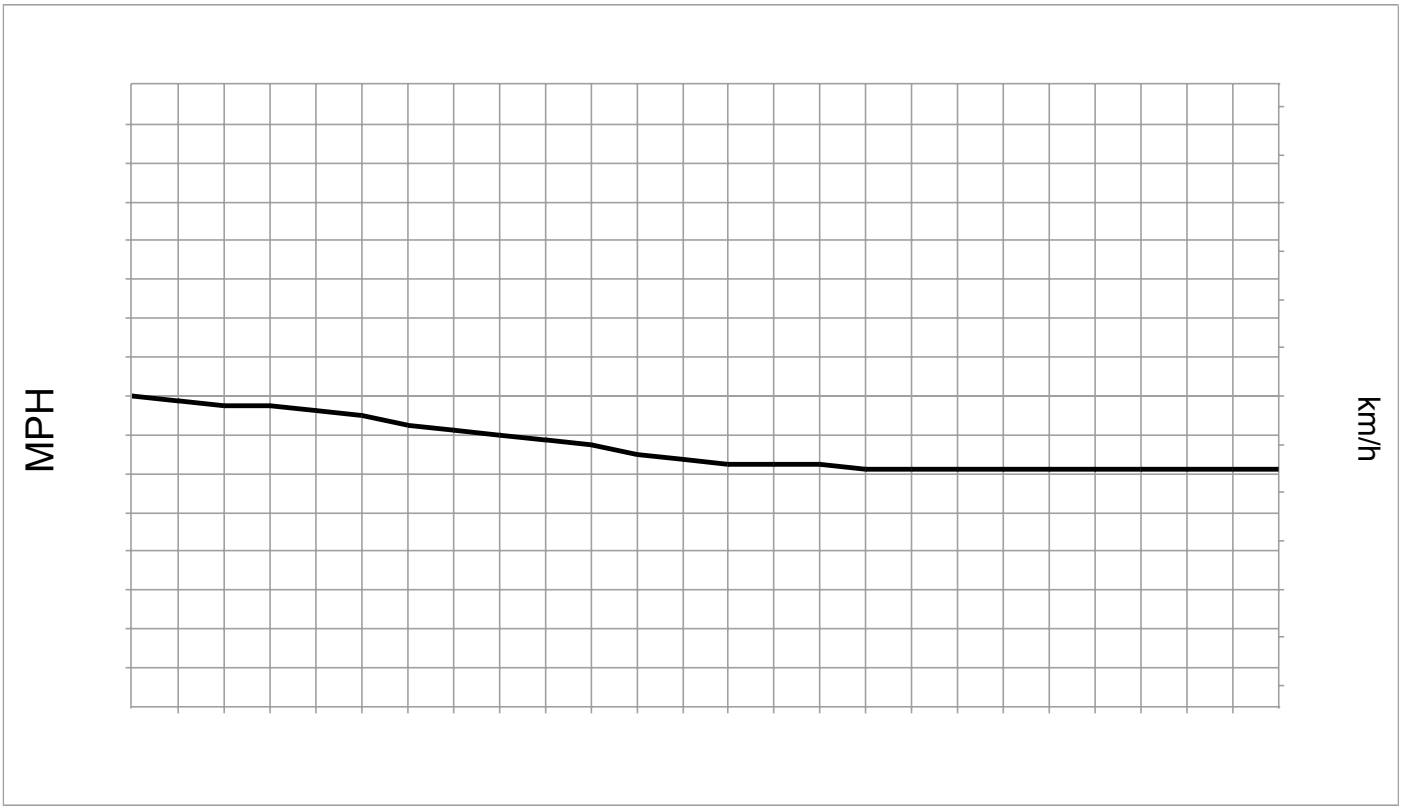
Time (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal (%)	Service Brake Activation
-5.0	85 [137]	0	Off
-4.5	85 [136]	60	Off
-4.0	86 [138]	71	Off
-3.5	88 [141]	74	Off
-3.0	90 [145]	71	Off
-2.5	93 [149]	72	Off
-2.0	94 [152]	52	Off
-1.5	93 [150]	9	Off
-1.0	90 [145]	0	Off
-0.5	80 [128]	100	On
0.0	69 [111]	0	On

Longitudinal Crash Pulse (Record 1, Most Recent)



Time (msec)	Delta-V, Longitudinal (MPH [km/h])
0	0.0 [0]
10	0.0 [0]
20	0.0 [0]
30	-0.6 [-1]
40	-0.6 [-1]
50	-0.6 [-1]
60	-0.6 [-1]
70	-0.6 [-1]
80	-1.2 [-2]
90	-1.2 [-2]
100	-1.2 [-2]
110	-1.2 [-2]
120	-1.2 [-2]
130	-1.9 [-3]
140	-1.9 [-3]
150	-1.9 [-3]
160	-1.9 [-3]
170	-1.9 [-3]
180	-1.9 [-3]
190	-1.9 [-3]
200	-1.9 [-3]
210	-1.9 [-3]
220	-1.9 [-3]
230	-1.9 [-3]
240	-1.9 [-3]
250	-1.9 [-3]

Lateral Crash Pulse (Record 1, Most Recent)



Time (msec)	Delta-V, Lateral (MPH [km/h])
0	0.0 [0]
10	-0.6 [-1]
20	-1.2 [-2]
30	-1.2 [-2]
40	-1.9 [-3]
50	-2.5 [-4]
60	-3.7 [-6]
70	-4.3 [-7]
80	-5.0 [-8]
90	-5.6 [-9]
100	-6.2 [-10]
110	-7.5 [-12]
120	-8.1 [-13]
130	-8.7 [-14]
140	-8.7 [-14]
150	-8.7 [-14]
160	-9.3 [-15]
170	-9.3 [-15]
180	-9.3 [-15]
190	-9.3 [-15]
200	-9.3 [-15]
210	-9.3 [-15]
220	-9.3 [-15]
230	-9.3 [-15]
240	-9.3 [-15]
250	-9.3 [-15]

System Status at Event (Record 2)

Event Type	Frontal
Time From Time Zero to Frontal Threshold (Beginning of Impact) (msec)	273
Time From Time Zero to Side Threshold (Beginning of Impact) (msec)	743
Time From Time Zero to Algo Start (Front) (msec)	Algorithm Started at t0
Time From Time Zero to Algo Start (Side) (msec)	38
Time From Time Zero to Algo Start (Rear) (msec)	193
Time From Time Zero to Deployment (Rollover) (msec)	Algorithm Not Started
Time From Time Zero to Deployment (Pitchover) (msec)	Algorithm Not Started
Time From Time Zero to Algo Start (Pedestrian Protection) (msec)	Algorithm Not Started
Maximum Delta-V, Longitudinal (MPH [km/h])	-11.2 [-18]
Maximum Delta-V, Lateral (MPH [km/h])	4.3 [7]
Time, Maximum Delta-V, Longitudinal (msec)	298
Time, Maximum Delta-V, Lateral (msec)	295
Clipping Time Longitudinal Sensor (msec)	Clipping Not Reached
Clipping Time Lateral Sensor (msec)	Clipping Not Reached
Multi-Event, Number of Events	2. Event
Time From Previous Event to Current Event (msec)	373
Complete File Recorded, Generic, Prio 1 Data	Completed Successfully
Ignition Cycle, Crash (cycle)	2,663
Ignition Cycle, Download (cycle)	2,665
Vehicle Mileage (km)	10,590
Operating Time (min)	16,122
Vehicle Identification Number	55SWF6EB5GU******
Event Counter (counts)	2

Deployment Command Data (Record 2)

Frontal Air Bag, Time to 1st Stage Deployment, Driver (msec)	271
Frontal Air Bag, Time to 2nd Stage Deployment, Driver (msec)	276
Frontal Air Bag, Time to 3rd Stage (Vent) Deployment, Driver (msec)	Data Not Available
Frontal Air Bag, 2nd Stage Disposal, Driver	No Disposal
Frontal Air Bag, 3rd Stage (Vent) Disposal, Driver	Data Not Available
Frontal Air Bag, Time to 1st Stage Deployment, Front Passenger (msec)	271
Frontal Air Bag, Time to 2nd Stage Deployment, Front Passenger (msec)	276
Frontal Air Bag, Time to 3rd Stage (Vent) Deployment, Front Passenger (msec)	349
Frontal Air Bag, 2nd Stage Disposal, Front Passenger	No Disposal
Frontal Air Bag, 3rd Stage (Vent) Disposal, Front Passenger	No Disposal
Side Air Bag, Time to Deployment 1st Stage, Driver (msec)	315
Side Curtain/Tube Air Bag,Time to Deployment, Driver Side (msec)	Data Not Available
Pretensioner (1), Time to Deploy, Driver (msec)	Data Not Available
Side Air Bag, Time to Deployment 1st Stage, Front Passenger (msec)	Data Not Available
Side Curtain/Tube Air Bag, Time to Deployment, Passenger Side (msec)	Data Not Available
Pretensioner (1), Time to Deploy, Front Passenger (msec)	Data Not Available
Pretensioner (2), Time to Deploy, Driver (msec)	Data Not Available
Pretensioner (2), Time to Deploy, Front Passenger (msec)	Data Not Available
Pretensioner (3), Time to Deploy, Driver (msec)	278
Pretensioner (3), Time to Deploy, Front Passenger (msec)	278

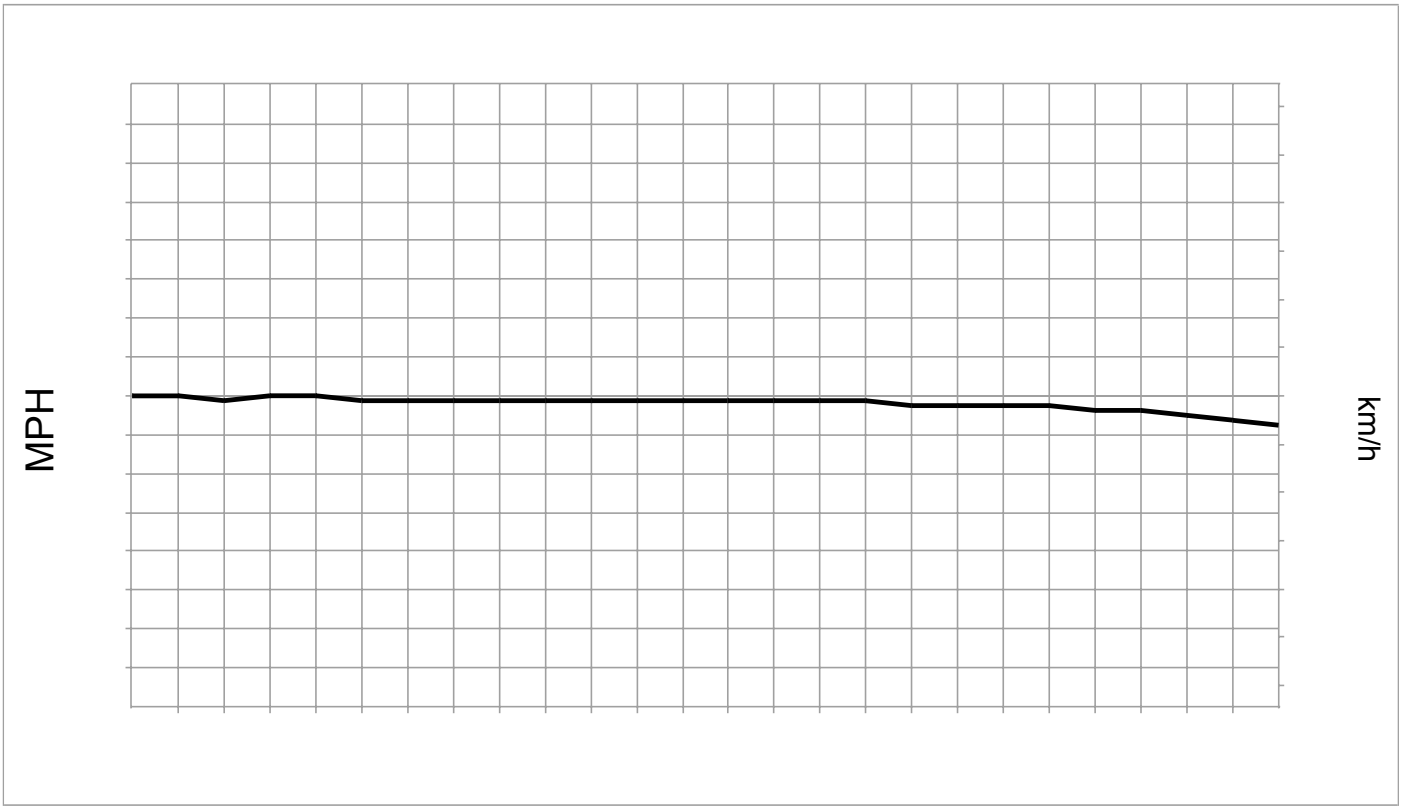
Pre-Crash Data -1 Sec (Record 2)

Safety Belt Status, Driver	Belted
Seat Track Position Switch Status, Driver	Rear
Air Bag Warning Lamp (AWL)	Off
Safety Belt Status, Front Passenger	Belted
Seat Track Position Switch Status, Front Passenger	Rear
Occupant Size Classification, Front Passenger	50% Male

Pre-Crash Data -5 to 0 sec (Record 2)

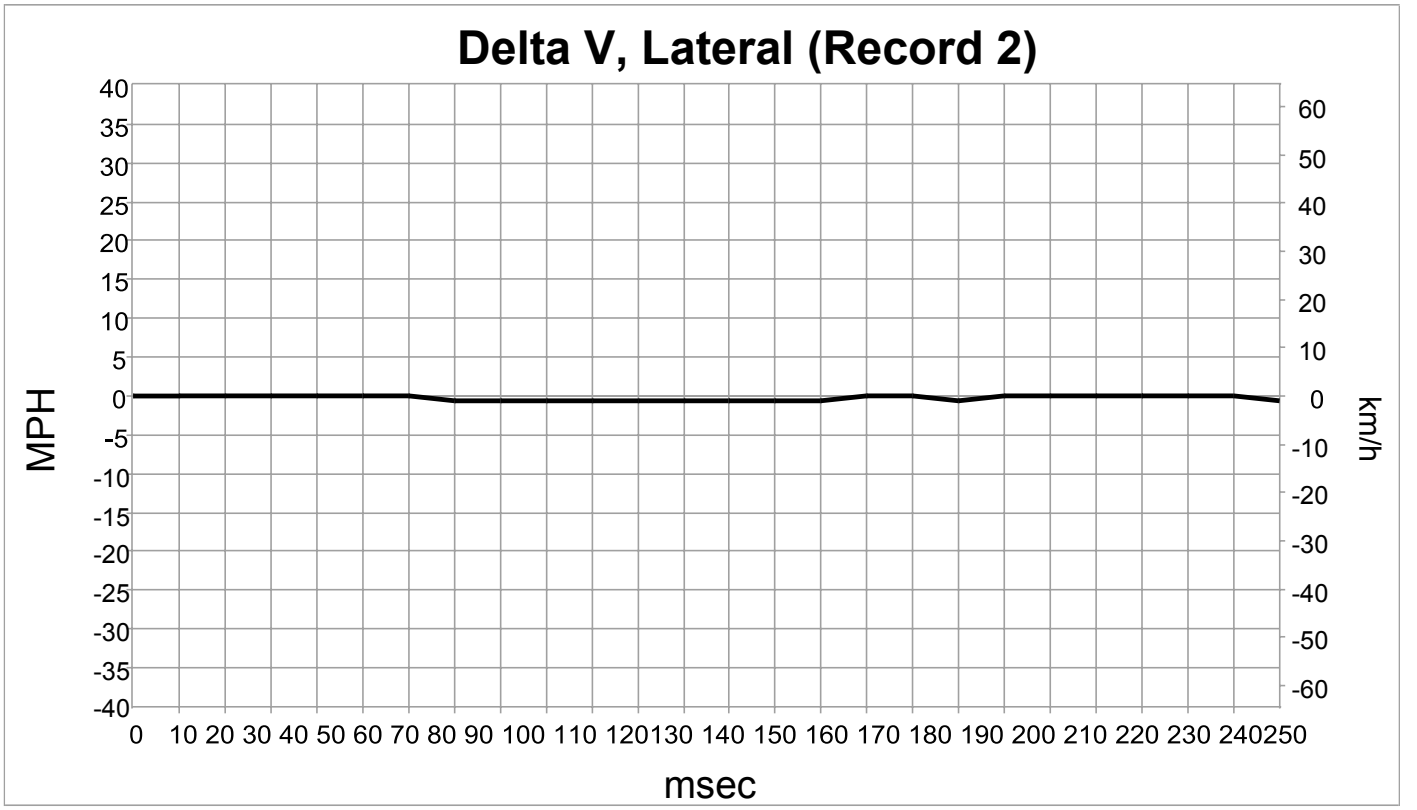
Time (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal (%)	Service Brake Activation
-5.0	89 [143]	0	Off
-4.5	88 [141]	0	Off
-4.0	86 [139]	0	On
-3.5	85 [137]	0	Off
-3.0	85 [136]	60	Off
-2.5	86 [138]	71	Off
-2.0	88 [141]	74	Off
-1.5	90 [145]	71	Off
-1.0	93 [149]	72	Off
-0.5	94 [152]	52	Off
0.0	93 [150]	9	Off

Longitudinal Crash Pulse (Record 2)



Time (msec)	Delta-V, Longitudinal (MPH [km/h])
0	0.0 [0]
10	0.0 [0]
20	-0.6 [-1]
30	0.0 [0]
40	0.0 [0]
50	-0.6 [-1]
60	-0.6 [-1]
70	-0.6 [-1]
80	-0.6 [-1]
90	-0.6 [-1]
100	-0.6 [-1]
110	-0.6 [-1]
120	-0.6 [-1]
130	-0.6 [-1]
140	-0.6 [-1]
150	-0.6 [-1]
160	-0.6 [-1]
170	-1.2 [-2]
180	-1.2 [-2]
190	-1.2 [-2]
200	-1.2 [-2]
210	-1.9 [-3]
220	-1.9 [-3]
230	-2.5 [-4]
240	-3.1 [-5]
250	-3.7 [-6]

Lateral Crash Pulse (Record 2)



Time (msec)	Delta-V, Lateral (MPH [km/h])
0	0.0 [0]
10	0.0 [0]
20	0.0 [0]
30	0.0 [0]
40	0.0 [0]
50	0.0 [0]
60	0.0 [0]
70	-0.6 [-1]
80	-0.6 [-1]
90	-0.6 [-1]
100	-0.6 [-1]
110	-0.6 [-1]
120	-0.6 [-1]
130	-0.6 [-1]
140	-0.6 [-1]
150	-0.6 [-1]
160	0.0 [0]
170	0.0 [0]
180	-0.6 [-1]
190	0.0 [0]
200	0.0 [0]
210	0.0 [0]
220	0.0 [0]
230	0.0 [0]
240	0.0 [0]
250	-0.6 [-1]

System Status at Event (Record 3)

Event Type	Rollover
Time From Time Zero to Frontal Threshold (Beginning of Impact) (msec)	203
Time From Time Zero to Side Threshold (Beginning of Impact) (msec)	200
Time From Time Zero to Algo Start (Front) (msec)	5
Time From Time Zero to Algo Start (Side) (msec)	25
Time From Time Zero to Algo Start (Rear) (msec)	Algorithm Started at t0
Time From Time Zero to Deployment (Rollover) (msec)	119
Time From Time Zero to Deployment (Pitchover) (msec)	Algorithm Not Started
Time From Time Zero to Algo Start (Pedestrian Protection) (msec)	Algorithm Not Started
Maximum Delta-V, Longitudinal (MPH [km/h])	-8.1 [-13]
Maximum Delta-V, Lateral (MPH [km/h])	-7.5 [-12]
Time, Maximum Delta-V, Longitudinal (msec)	300
Time, Maximum Delta-V, Lateral (msec)	285
Clipping Time Longitudinal Sensor (msec)	Clipping Not Reached
Clipping Time Lateral Sensor (msec)	Clipping Not Reached
Multi-Event, Number of Events	1. Event
Time From Previous Event to Current Event (msec)	0
Complete File Recorded, Generic, Prio 1 Data	Completed Successfully
Ignition Cycle, Crash (cycle)	2,663
Ignition Cycle, Download (cycle)	2,665
Vehicle Mileage (km)	10,590
Operating Time (min)	16,122
Vehicle Identification Number	55SWF6EB5GU******
Event Counter (counts)	1

Deployment Command Data (Record 3)

Frontal Air Bag, Time to 1st Stage Deployment, Driver (msec)	Data Not Available
Frontal Air Bag, Time to 2nd Stage Deployment, Driver (msec)	Data Not Available
Frontal Air Bag, Time to 3rd Stage (Vent) Deployment, Driver (msec)	Data Not Available
Frontal Air Bag, 2nd Stage Disposal, Driver	Data Not Available
Frontal Air Bag, 3rd Stage (Vent) Disposal, Driver	Data Not Available
Frontal Air Bag, Time to 1st Stage Deployment, Front Passenger (msec)	Data Not Available
Frontal Air Bag, Time to 2nd Stage Deployment, Front Passenger (msec)	Data Not Available
Frontal Air Bag, Time to 3rd Stage (Vent) Deployment, Front Passenger (msec)	Data Not Available
Frontal Air Bag, 2nd Stage Disposal, Front Passenger	Data Not Available
Frontal Air Bag, 3rd Stage (Vent) Disposal, Front Passenger	Data Not Available
Side Air Bag, Time to Deployment 1st Stage, Driver (msec)	Data Not Available
Side Curtain/Tube Air Bag,Time to Deployment, Driver Side (msec)	119
Pretensioner (1), Time to Deploy, Driver (msec)	119
Side Air Bag, Time to Deployment 1st Stage, Front Passenger (msec)	Data Not Available
Side Curtain/Tube Air Bag, Time to Deployment, Passenger Side (msec)	119
Pretensioner (1), Time to Deploy, Front Passenger (msec)	119
Pretensioner (2), Time to Deploy, Driver (msec)	Data Not Available
Pretensioner (2), Time to Deploy, Front Passenger (msec)	Data Not Available
Pretensioner (3), Time to Deploy, Driver (msec)	Data Not Available
Pretensioner (3), Time to Deploy, Front Passenger (msec)	Data Not Available

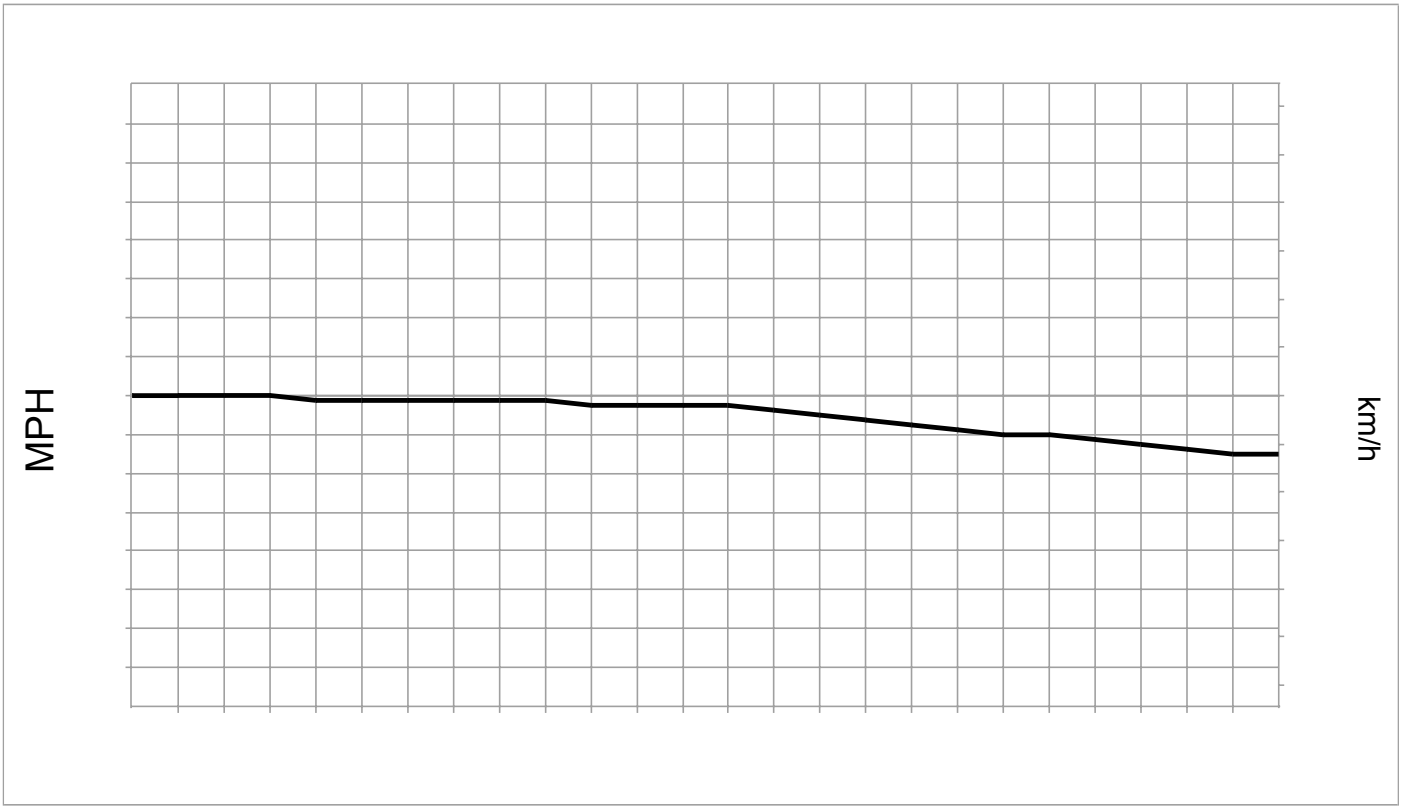
Pre-Crash Data -1 Sec (Record 3)

Safety Belt Status, Driver	Belted
Seat Track Position Switch Status, Driver	Rear
Air Bag Warning Lamp (AWL)	Off
Safety Belt Status, Front Passenger	Belted
Seat Track Position Switch Status, Front Passenger	Rear
Occupant Size Classification, Front Passenger	50% Male

Pre-Crash Data -5 to 0 sec (Record 3)

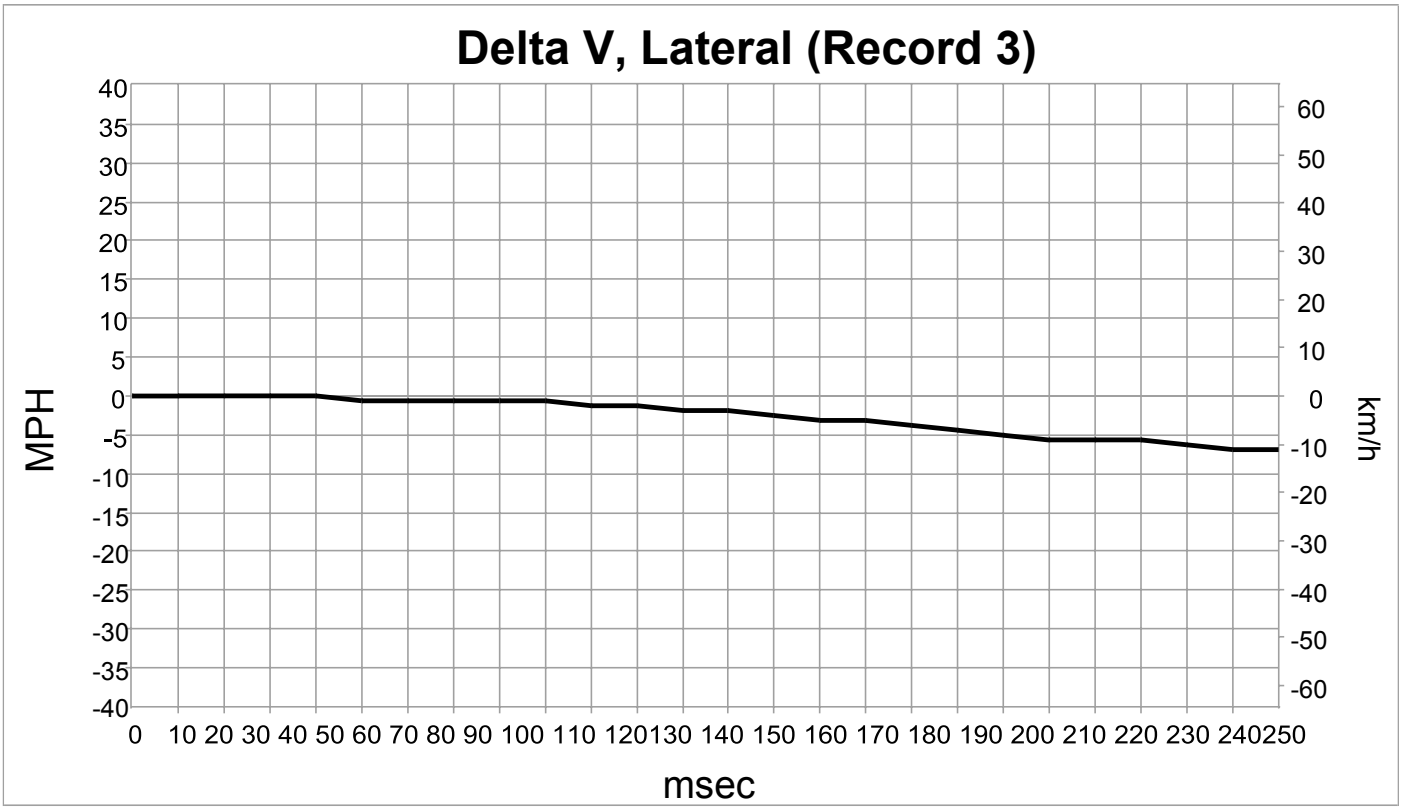
Time (sec)	Speed, Vehicle Indicated (MPH [km/h])	Accelerator Pedal (%)	Service Brake Activation
-5.0	89 [143]	0	Off
-4.5	88 [141]	0	Off
-4.0	86 [139]	0	On
-3.5	85 [137]	0	Off
-3.0	85 [136]	60	Off
-2.5	86 [138]	71	Off
-2.0	88 [141]	74	Off
-1.5	90 [145]	71	Off
-1.0	93 [149]	72	Off
-0.5	94 [152]	52	Off
0.0	93 [150]	9	Off

Longitudinal Crash Pulse (Record 3)



Time (msec)	Delta-V, Longitudinal (MPH [km/h])
0	0.0 [0]
10	0.0 [0]
20	0.0 [0]
30	0.0 [0]
40	-0.6 [-1]
50	-0.6 [-1]
60	-0.6 [-1]
70	-0.6 [-1]
80	-0.6 [-1]
90	-0.6 [-1]
100	-1.2 [-2]
110	-1.2 [-2]
120	-1.2 [-2]
130	-1.2 [-2]
140	-1.9 [-3]
150	-2.5 [-4]
160	-3.1 [-5]
170	-3.7 [-6]
180	-4.3 [-7]
190	-5.0 [-8]
200	-5.0 [-8]
210	-5.6 [-9]
220	-6.2 [-10]
230	-6.8 [-11]
240	-7.5 [-12]
250	-7.5 [-12]

Lateral Crash Pulse (Record 3)



Time (msec)	Delta-V, Lateral (MPH [km/h])
0	0.0 [0]
10	0.0 [0]
20	0.0 [0]
30	0.0 [0]
40	0.0 [0]
50	-0.6 [-1]
60	-0.6 [-1]
70	-0.6 [-1]
80	-0.6 [-1]
90	-0.6 [-1]
100	-1.2 [-2]
110	-1.2 [-2]
120	-1.9 [-3]
130	-1.9 [-3]
140	-2.5 [-4]
150	-3.1 [-5]
160	-3.1 [-5]
170	-3.7 [-6]
180	-4.3 [-7]
190	-5.0 [-8]
200	-5.6 [-9]
210	-5.6 [-9]
220	-5.6 [-9]
230	-6.2 [-10]
240	-6.8 [-11]
250	-6.8 [-11]

Hexadecimal Data

```
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FA12    0100 00  06 45 00 00 05 C5

FA11    0100 03

FA13    0003 00  01 01 00 02 FF FF 00 03  00 4A 00 04 00
        0800 05  00 00 00 06 00 04 00 07  FF FF 00 08 FF
        FF00 09  FF FF 00 1F 64 00 00 19  7F 7F 7F 7E 7E
        7E7E 7E  7D 7D 7D 7D 7D 7C 7C 7C  7C 7C 7C 7C 7C
        7C7C 7C  7C 7C 00 20 64 00 00 19  7F 7E 7D 7D 7C
        7B79 78  77 76 75 73 72 71 71 71  70 70 70 70 70
        7070 70  70 70 00 21 7C 00 22 70  00 23 77 00 24
        3C00 28  FF 00 29 FF 00 2D 03 00  2E 09 10 00 33
        FFFF 00  34 FF FF 00 35 FF FF 00  36 FF 00 37 FF
        0038 FF  FF 00 39 FF FF 00 3A FF  FF 00 3B FF 00
        3CFF 00  3D FF FF 00 3E FF FF 00  3F FF FF 00 41
        FFFF 00  42 FF FF 00 43 FF FF 00  47 01 00 48 02
        004B 00  00 4D 01 00 4E 02 00 4F  03 00 5B 89 88
        8A8D 91  95 98 96 91 80 6F 00 5C  00 3C 47 4A 47
        4834 09  00 64 00 00 5F 00 00 00  00 00 00 00 00
        0001 01  00 6D FF FF 00 6E FF FF  00 70 FF FF 00
        71FF FF  03 E8 A5 03 E9 0A 67 03  EA 0A 69 03 F1
        0423 03  F2 00 3E FA 03 F3 35 35  53 57 46 36 45
        4235 47  55 2A 2A 2A 2A 2A 2A 03  FB 04 03 FD 00
        0303 FE  D3 EE B2 AE

FA14    0002 00  01 00 00 02 01 11 00 03  02 E7 00 04 00
        0000 05  00 26 00 06 00 C1 00 07  FF FF 00 08 FF
        FF00 09  FF FF 00 1F 64 00 00 19  7F 7F 7E 7F 7F
        7E7E 7E  7E 7E 7E 7E 7E 7E 7E 7E  7E 7D 7D 7D 7D
        7C7C 7B  7A 79 00 20 64 00 00 19  7F 7F 7F 7F 7F
        7F7F 7E  7E 7E 7E 7E 7E 7E 7E 7E  7F 7F 7E 7F 7F
        7F7F 7F  7F 7E 00 21 6D 00 22 86  00 23 77 00 24
        7600 28  FF 00 29 FF 00 2D 02 00  2E 02 EA 00 33
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        8B89 88  8A 8D 91 95 98 96 00 5C  00 00 00 00 3C
        474A 47  48 34 09 00 5F 00 00 01  00 00 00 00 00
        0000 00  00 6D FF FF 00 6E FF FF  00 70 01 16 00
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        0423 03  F2 00 3E FA 03 F3 35 35  53 57 46 36 45
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        0203 FE  A4 76 12 7C

FA15    0001 00  01 03 00 02 00 CB 00 03  00 C8 00 04 00
        0500 05  00 19 00 06 00 00 00 07  00 77 00 08 FF
        FF00 09  FF FF 00 1F 64 00 00 19  7F 7F 7F 7F 7E
        7E7E 7E  7E 7E 7D 7D 7D 7D 7C 7B  7A 79 78 77 77
        7675 74  73 73 00 20 64 00 00 19  7F 7F 7F 7F 7F
        7E7E 7E  7E 7E 7D 7D 7C 7C 7B 7A  7A 79 78 77 76
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        FFFF 00  42 00 77 00 43 00 77 00  47 01 00 48 02
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          474A 47  48 34 09 00 5F 00 00 01  00 00 00 00 00
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          4235 47 55 2A 2A 2A 2A 2A 2A 03 FB 04 03 FD 00
          0103 FE 3F DA 87 C2
FA16      0000

FA17      0000

FA18      0000
```

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June 2018

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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