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Special Crash Investigations On-Site Rear Impact Crash and Fire Investigation Vehicle: 2007 Jeep Liberty Location: Ohio Date: August 2017

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16. Abstract This report documents the on-site investigation of the rear impact crash and post-impact fire in a 2007 Jeep Liberty that was struck on the back plane by a 2003 Buick Century. The Jeep was driven by a 58-year-old female who sustained fatal injuries related to the fire. The Jeep Liberty in model years 2002-2007 was under recall for the potential of a post-collision fire after a rear impact (NHTSA Campaign Number 13V252000). The remedy to the recall was the installation of an OEM rear trailer hitch. A query of the NHTSA web site www.safercar.gov on September 7, 2017, with the Jeep's vehicle identification number (VIN) determined that there were no open recalls on the Jeep at the time of the crash. A vehicle history report indicated that in December 2014 the recall apparently had been addressed during a vehicle maintenance inspection and the trailer hitch installation. The event data recorder (EDR) of the striking Buick Century was removed from the vehicle during the police investigation and its imaged data was later shared with the SCI team. The imaged data reported that the pre-crash speed of the Buick was 150 km/h (93 mph) 5 seconds prior to algorithm enable (AE) and the vehicle had slowed to a recorded speed of 113 km/h (70 mph) 1 second prior to AE.			
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Special Crash Investigations
On-Site Rear Impact Crash and Fire Investigation
Office of Defects Investigation
Case Number: CR17025
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BACKGROUND

The report documents the on-site investigation of the rear impact and post-crash fire in a 2007 Jeep Liberty (**Figure 1**) that was struck on the back plane by a 2003 Buick Century. The Jeep was driven by a 58-year-old female who sustained fatal injuries related to the fire. The Jeep Liberty in model years 2002 to 2007 was under recall for the potential of a post-collision fire after a rear impact (NHTSA Campaign Number 13V252000). The remedy to the recall was the installation of an OEM rear trailer hitch. A query of the NHTSA website www.nhtsa.gov in September 2017 with the Jeep's Vehicle Identification Number (VIN) determined that there were no open recalls on the Jeep at the time of the crash. A vehicle history report indicated that in December 2014 the recall had been addressed by a vehicle maintenance inspection and the trailer hitch installation.

Figure 1. Back view of the Jeep Liberty depicting its deformation and fire damage.

NHTSA was notified of the crash through an internet news-media search for crashes of interest and contacted the investigating police department. Further research of the crash was requested through NHTSA's Crash Investigation Division and an on-site investigation was assigned to the Special Crash Investigations team at Crash Research & Analysis, Inc., in September 2017. The SCI team contacted the law enforcement agency and set up an inspection of the involved vehicles and crash site, which took place in September 2017.

The Jeep and Buick were both traveling northbound at the time of the early morning crash that occurred at a four-leg intersection. The Jeep was driven by a 58-year-old female and was estimated to have been traveling at a slow rate of speed. The Buick was driven by a 40-year-old female at what appeared to be a significantly higher rate of speed. Data imaged from the Buick's event data recorder (EDR) reported that the pre-crash speed of the Buick was 150 km/h (93 mph) 5 seconds prior to algorithm enable (AE) and the vehicle had slowed to a recorded speed of 113 km/h (70 mph) 1 second prior to AE.

The front plane of the Buick struck the back plane of the Jeep. The force of the impact displaced the vehicles forward along the roadway 31 m (101.7 ft) to the northwest. The Jeep rotated counterclockwise approximately 180 degrees and its right plane came to rest against a traffic light support pole. The Buick came to final rest engaged against the left plane of the Jeep.

A crash-induced fire developed in the Jeep and spread to the Buick post impact. The first responders were unable to approach the Jeep due to the heat of the flames and were not able to assist the driver, who was fatally injured and pronounced deceased at the crash site. The Buick's driver was assisted from the vehicle and transported by ambulance to a local hospital then transferred by helicopter to a regional trauma center with police-reported incapacitating (A-level) injuries.

The on-site activities consisted of an inspection of the Jeep, measurement of the structural deformation and intrusion, an assessment of interior occupant loading and manual restraint use, and a thorough examination of the Jeep's rear structure, trailer hitch, and fuel system. The Jeep was not equipped with an EDR supported by Bosch Crash Data Retrieval (CDR) tool. The Buick was inspected and its exterior deformation was documented. The Buick was equipped with an EDR that was supported by the Bosch CDR tool. The EDR had been removed during the police investigation, imaged, and the module was stored in evidence. A PDF copy of the police imaging was given to the SCI team and is included in this report. The crash site was inspected and the physical evidence and physical plant were measured by Total Station during the on-site activities.

SUMMARY

Crash Site

The crash occurred during the morning in August 2017 in an urban residential setting. At the time of the crash, the weather conditions reported by the National Weather Service were a temperature of 16.1 °C (61.0 °F), 80 percent relative humidity, 9.3 km/h (5.8 mph) south-southeast winds, clear visibility, and partly cloudy skies. The police-reported conditions were cloudy, dry, and dark with artificial overhead street lighting.

The crash occurred at the four-leg intersection of a multi-lane north/south road and a one-way (westbound) roadway. The intersection had recently been resurfaced with asphalt and was absent any lane markings. The north/south roadway consisted of one southbound lane and two northbound lanes. Each northbound lane measured 3.2 m (10.5 ft) wide. On the northbound approach to the intersection, the roadway was delineated by a double yellow center line that separated the travel directions and a solid white line delineated the northbound travel lanes. Concrete curbs, grass and sidewalks bordered the road edges in the residential environment. Traffic light supports and utility

Figure 2. North-facing trajectory view 100 m (328 ft) south of the POI.

poles were located at each quadrant of the intersection. The non-breakaway traffic light support pole at the northwest quadrant was struck by the Jeep in a secondary impact as the vehicle came to final rest. The posted speed limit was 56 km/h (35 mph). **Figure 2** is a north-facing view along pre-crash trajectory of the vehicles. **Figure 3** is a north-facing view at the point of impact.

Pre-Crash

The Jeep was northbound in the left lane driven by the 58-year-old female. The SCI crash reconstruction (conversation of momentum analysis) determined that the vehicle was traveling approximately 16 to 24 km/h (10 to 15 mph) as it approached the four-leg intersection. The Buick, driven by the 40-year-old female, was traveling at an EDR-reported speed of 150 km/h (93 mph) 5-seconds prior to algorithm enable (AE). The physical evidence at the crash site (a skid mark) indicated that the Buick driver braked and steered right in an attempt to avoid the slower-moving Jeep. The 9.3 m (30.5 ft) long skid mark, which began 7.5 m (24.6 ft) prior to the impact and extended beyond the area of impact, was attributed to the right front tire of the Buick. The EDR-reported speed of the Buick 1-second prior to AE was 113 km/h (70 mph). The SCI reconstructed speed of the Buick was approximately 97 km/h (60 mph) at impact. The subsequent police investigation determined that the Buick driver was alcohol/drug-impaired.

Crash

The front plane of the Buick struck and underrode the back plane of the Jeep (Event 1). The impact configuration of the vehicle was biased to the right aspect of the Jeep with an approximate 70 percent overlap. The centerline of the Buick was oriented 42 cm (16.5 in) to the right of the centerline of the Jeep at impact. The point of impact was located in the left northbound lane at the transition from the old asphalt to the new paved intersection evidenced by a pattern of gouge marks in the asphalt attributed to the undercarriage of the Buick. The force of the

Figure 3. North-facing view of the POI.

Figure 4. Northwest-facing image depicting the point of impact and the crash scene. Image supplied by an Internet news source.

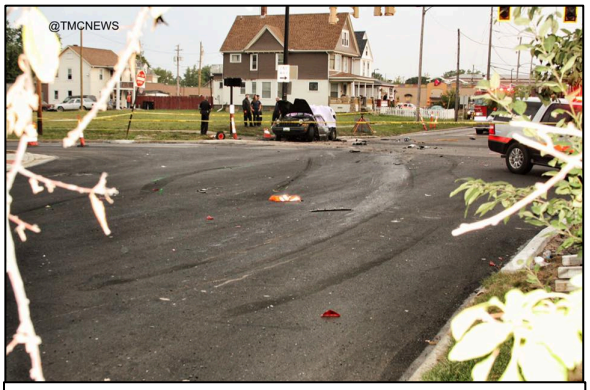


Figure 5. Northwest-facing image depicting the yaw trajectory to final rest. Image supplied by an Internet news source. Image was taken after the removal of the Buick.

impact displaced the Jeep forward and caused both vehicles to initiate a counterclockwise rotation as they reached maximum engagement. On-scene images taken by an internet news source depict multiple counterclockwise yaw marks through the newly-paved intersection (**Figures 4** and **5**). Due to the passage of time, the majority of those marks had faded and were not visible during the SCI scene inspection.

Two counterclockwise-arcing tire marks attributed to the forced movement of the Jeep were observed during the SCI scene inspection. A tire mark 7.4 m (24.3 ft) in length was located in the left northbound lane and was attributed to the Jeep's left front tire. The second tire mark was located in the intersection and measured 3.7 m (12.1 ft) in length. This mark was attributed to the left rear tire of the Jeep after it had separated from the Buick.

The compression and deformation of the Jeep's rear structure compressed the fuel tank forward against the rear axle and differential. The high-density polyethylene (HDPE) fuel tank deformed and ruptured. Fuel vapors ignited after the impact (Event 2) and were subsequently fueled by the leakage.

The Jeep rotated 160 degrees counterclockwise as it crossed through the intersection and approached the northwest quadrant of the intersection. As it encountered the curb, the right front door of the vehicle struck the utility pole located adjacent to the curb (Event 3). This impact halted the vehicle's movement and the Jeep rotated an additional 20 degrees (approximately) around the pole, coming to final rest. At final rest, the Jeep (**Figure 6**) was facing south 31.9 m (104.7 ft) from the initial point of impact.

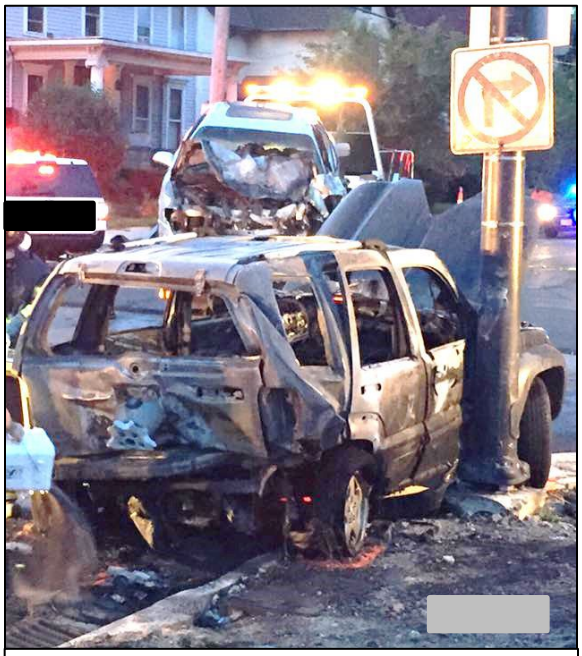


Figure 6. Southeast-facing view depicting the final rest position of the Jeep. Image supplied by an Internet news source.

After its separation from the Jeep, the Buick continued on an arcing counterclockwise trajectory following the Jeep and slid to final rest against the Jeep's left plane (Event 4). Damage to the forward aspect of the Jeep's left sill and A-pillar area identified the contact. At rest the Buick was facing northwest 34.9 m (114.5 ft) from the initial impact. The severity of the impact (delta V) was calculated by the damage algorithm of the WinSMASH program. The calculated delta Vs of the Jeep and Buick were 51 km/h (32 mph) and 64 km/h (40 mph) respectively.

Post-Crash

The fire consumed the aft two-thirds of the Jeep and was spreading to the Buick at the arrival of the first responders. The flames were too intense for the first responders to approach the Jeep and

offer aid to its driver. As the flames began to spread to the Buick, its driver was assisted from the vehicle and transported by ambulance to a local hospital and then transferred by helicopter to a regional trauma center with police-reported incapacitating (A-level) injuries. Firefighters used water to suppress and extinguish the fire. The Jeep driver was fatally injured and pronounced deceased at the crash site. The Jeep and Buick were removed from the scene by a local tow agent and impounded by the police pending the completion of their investigation.

2007 JEEP LIBERTY

Description

The 2007 Jeep Liberty Trail Rated 4x4 (**Figure 7**) was identified by the Vehicle Identification Number (VIN) 1J4GL48K37Wxxxxxx, which was determined by the police through registration records. The date of manufacturer is unknown as the crash-induced fire consumed all labeling. The sport utility vehicle (SUV) was built on a 265 cm (104.4 in) wheelbase and had a gross vehicle weight rating (GVWR) of 2,540 kg (6,150 lb). The front axle and rear axle ratings were 1,179 kg (2,599 lb) and 1,429 kg (3,150 lb), respectively. The curb weight was 1,819 kg (4,002 lb). The Jeep was powered by a conventionally mounted 3.7-liter, V-6, gasoline engine linked to a 4-speed automatic transmission with a console-mounted shift lever. Power was transmitted to the front and rear axles via drive shafts from the transfer case that was mounted to the aft aspect of the automatic transmission. Specifications for this vehicle listed the following as standard equipment: traction control, electronic stability control, power-assisted four-wheel disc brakes with ABS, electronic brakeforce distribution, emergency braking assist, and power-assisted rack-and-pinion steering. The vehicle manufacturer recommended tire size was P225/75R16. At the time of the crash, the Jeep was equipped with matching Firestone Destination tires of the recommended size. All tires were mounted on OEM 5-spoke alloy wheels. The rear tires sustained fire damage; however, they were not completely consumed. The specific tire data at the time of the SCI inspection is listed in the following table. It should be noted that the fire fighters removed the valve stems from the wheels to stabilize the vehicle during the extrication efforts; therefore, all tires were flat.

Figure 7. Right rear oblique view of the Jeep.

Position	Tire Identification Number	Measured Tread Depth	Restricted	Damage
LF	VN71 DE1 9999	7 mm (9/32 in)	No	None
LR	Unknown	6 mm (7/32 in)	No	Partially burned
RR	Unknown	5 mm (6/32 in)	Yes	Partially burned, debeaded
RF	Unknown	6 mm (8/32 in)	No	None

The interior of the Jeep was configured for seating of five occupants with front row bucket seats and a second row forward-folding split-bench seat (right side wide). Both front row bucket seats

had integrated head restraints while the second row was configured with adjustable head restraints for the three positions. The driver seat was adjusted between the middle and rear track position. The fire consumed the entire interior of the Jeep. Standard safety systems consisted of continuous loop 3-point lap and shoulder seat belts for the five designated seat positions. The front row seat belt systems were equipped with adjustable D-rings. Supplemental restraint was provided by Certified Advanced 208-Complaint (CAC) frontal air bags and retractor pretensioners for the driver and front row right positions. The certification label was inaccessible, as the doors were inoperative.

NHTSA Recalls and Investigation

A November 2019 query of the NHTSA website www.nhtsa.gov/recalls with the Jeep's VIN determined that there were no unrepaired recalls concerning the vehicle. The Jeep Liberty in model years 2002 to 2007 was under recall for the potential of a post-collision fire after a rear impact (NHTSA Campaign Number 13V252000). The remedy to the recall was the installation of an OEM rear trailer hitch.

Vehicle History

A vehicle history report stated that the Jeep was first sold and titled in January 2007. This ownership continued until April 2010. At that time the vehicle was purchased by the driver who was involved in this crash. The vehicle had 59,359 km (36,885 miles) at the time of the sale with continuous ownership by the driver until the date of the crash. There was no history of prior crashes. Over the course of the driver's 7-plus year ownership period, the history report chronicled multiple instances of routine maintenance. Most notable was the documentation of a complete maintenance inspection and a trailer hitch installation in December 2014 that most likely was conducted as a remedy to the NHTSA rear-impact/post-collision fire recall. The reported mileage at this service was 104,127 km (64,703 miles). The last reported vehicle service occurred in May 2017 with a reported mileage of 133,572 km (83,000 miles).

Exterior Damage

The Jeep sustained damage to the back, right, and left planes during this multiple event crash. The Event 1 impact involved the hood and upper radiator support of the Buick against the lift gate-mounted spare tire and back structure of the Jeep. Based on an exemplar vehicle, the spare tire protruded 30 cm (12 in) beyond the vertical profile of the lift gate. The impact compressed the spare tire and wheel against the lift gate, crushing the lift gate and disintegrating the backlight. The combination of the height of the Jeep and the compression of the Buick's front suspension resulting from pre-crash braking allowed the Buick's front bumper to engage and underride the back bumper of the Jeep. The Buick's bumper structure struck the Jeep's Class

Figure 8. Forward-looking view of the Jeep's deformed trailer hitch.

III trailer hitch. The hitch was displaced forward and rotated downward 90 degrees, evidenced by the vertical position of the 5 cm (2 in) receiver sleeve (**Figure 8**). It should be noted that the hitch did not contain a ball-mount at the time of the inspection. The left frame attachment bracket of the hitch tore and deformed over a 6 cm (2.5 in) length. The aft attachment bolt at the right frame attachment bracket pulled through the frame and deformed (**Figure 9**). Consequently, the trailer hitch compressed the HDPE fuel tank against the rear differential and axle tubes. The HDPE fuel tank ruptured from a probable over-pressurization of fuel, causing an immediate fuel leakage and subsequent fire (Event 2).

Figure 9. Forward-looking view of the right aspect of the Jeep's traile hitch and the deformed right frame attachment bracket.

Figures 10 and 11 are the back and right lateral views of the Jeep depicting the deformation of the back structure. The direct contact damage was documented at the level of the bumper beam as the polymer bumper fascia was completely consumed by the ensuing fire. The direct contact damage began 19 cm (7.4 in) left of the vehicle's centerline and extended 98 cm (38.4 in) to the right corner. The combined direct and induced damage was 154 cm (60.5 in) and extended the full width of the bumper beam. The crush profile documented at the level of the bumper beam less freespace was as follows: C1 = 0, C2 = 15 cm (5.9), C3 = 20 cm (7.9 in), C4 = 24 cm (9.4 in), C5 = 31 cm (12.2 in), and C6 = 40 cm (15.7 in). Maximum crush was located at the right end of the bumper beam. The right wheelbase was reduced 22 cm (8.5 in) with collapse of the right rear wheelhouse. The Collision Deformation Classification (CDC) representative of this damage pattern was 06BZEW3. The delta V calculated by the WinSMASH Damage Algorithm was 51 km/h (32 mph) with longitudinal and lateral components of -51 km/h (-32 mph) and -0, respectively.

Figure 10. Back view of the Jeep depicting the deformation.

Figure 11. Right lateral view of the Jeep at its back plane.

The right plane of the Jeep (**Figure 12**) sustained impact damage consistent with the impact to the traffic light support located at the northwest quadrant of the intersection (Event 3). The direct contact damage began 5 cm (2 in) forward of the leading edge of the right front door [64 cm (25.0 in) aft of the right front axle]. The direct damage extended 41 cm (16.0 in) rearward. Vertically, the pole contact damage extended 33 cm (13.0 in) above the beltline onto the upper right A-pillar. The combined direct and induced damage length for the Event 3 crash event was 100 cm (39.5 in), extending the full length of the right front door. The crush profile was documented along the mid-door and was as follows: C1 = 1 cm (0.4 in), C2 = 4 cm (1.6 in), C3 = 7 cm (2.8 in), C4 = 10 cm (3.9 in), C5 = 9 cm (3.5 in), and C6 = 2 cm (0.8 in). The WinSMASH delta V calculated by the barrier algorithm was 10 km/h (6 mph) with longitudinal and lateral components of -5 km/h (-3 mph) and -9 km/h (-5 mph), respectively. The CDC for this event was 02RPAW2.

Figure 12. Right view depicting the Jeep's pole impact damage.

The Buick separated from the Jeep after the Event 1 impact and followed the Jeep on a counterclockwise trajectory across the intersection. As the Jeep came to rest, the Buick struck the left plane of the Jeep (Event 4) at the left front fender, door and sill areas. The direct contact damage began at the leading edge of the sill, 43 cm (17 in) aft of the left front axle position and extended 89 cm (35.0 in) rearward onto the lower left front door panel and sill. Crush was minimal with 4 cm (1.5 in) of crush occurring along the sill. The CDC assigned to this damage pattern was 10LYEW2.

The back lift gate of the Jeep was jammed closed by the deformation from the Event 1 crash. The backlight glazing was disintegrated by the crash forces. Both rear doors of the Jeep were jammed closed by the exterior deformation. Post-crash, firefighters cut the hinges to the rear doors and pried open the latches to remove the doors from the Jeep to facilitate the extrication of the driver's body. Both front doors appeared to have been operational immediately following the crash, but were restricted from opening by the traffic light support and the final rest position of the Buick. The door linkages were then consumed in the fire rendering the front doors inoperative.

Interior Damage

The interior of the Jeep (**Figure 13**) was completely destroyed by the fire. All combustible materials were consumed, with only the steel framework of the seats and instrument panel remaining. The driver's seat back was deflected rearward onto the seat frame of the second-row

left seat. This was due to the driver loading the seatback during the crash. The unoccupied front row right seatback was rotated in a counterclockwise direction with the upper left quadrant of the seatback deflected rearward. This appeared to have resulted from driver contact during the initial Event 1 crash with the Buick.

The second-row interior of the Jeep was reduced in size by intrusion of the second-row seat resulting from structural deformation to the back plane (**Figure 14**). The seat bight was displaced forward and was used to document the extent of occupant compartment intrusion. The intrusions at the second-row seat bight were 9 cm (3.5 in) at the left position, 17 cm (6.5 in) at the second-row center position and 22 cm (8.5 in) at the second-row right position.

The Jeep was manufactured with an AS1 laminated windshield that was bonded in its structural frame. The front door glazing was AS2 tempered and the rear door, quarter windows, backlight and sunroof glazing were AS3 glazing. Based on vehicle damage, the backlight, the right rear quarter window, and the right rear door glazing were disintegrated during the crash. All other glazing was consumed by the fire. An inspection of the inner door window regulators/ tracks indicated the driver's window was probably opened approximately 2/3rds at the time of the crash. All other door glazing based on track positions were presumed to be closed. The pre-crash status of the roof glazing is unknown.

Fuel System

The Jeep was configured with a 77.6-liter (20.5 gal) high density polyethylene (HDPE) fuel tank mounted to the undercarriage aft of the rear axle. Based on an inspection of an exemplar vehicle (**Figure 15**), the overall dimensions of the fuel tank were 86 cm (34 in) in width, 33 cm (13 in) in height, and 38 cm (15 in) in depth (longitudinal). The rectangular tank was secured

Figure 13. Interior view of the Jeep at the second row left looking forward.

Figure 14. Right interior view depicting the second-row intrusion of the Jeep.

Figure 15. Rear view of the fuel tank and its location on an exemplar Jeep Liberty.

with two steel straps 4 cm (1.5 in) wide and 3 mm (0.125 in) thick. Both straps were bolted to sheet metal undercarriage cross members. The fuel filler tube extended from the left side of the fuel tank and was located at the upper aspect of the left rear quarter panel, aft of the axle location. A ratcheting plastic fuel cap closed the tube. A composite hinged fuel door closed the filler cap port. The steel filler tube was 30 cm (11.75 in) in overall length and was connected to the tank by a neoprene hose. A steel overflow tube extended from the head of the filler tube and was formed to the contour of the tube. The steel filler tube and the overflow tube remained intact while all connecting neoprene tubing was consumed by the fire. The filler tube was found in the passenger compartment of the Jeep as it had separated from its plastic mounting support. The amount of gasoline in the fuel tank at the time of the crash is unknown.

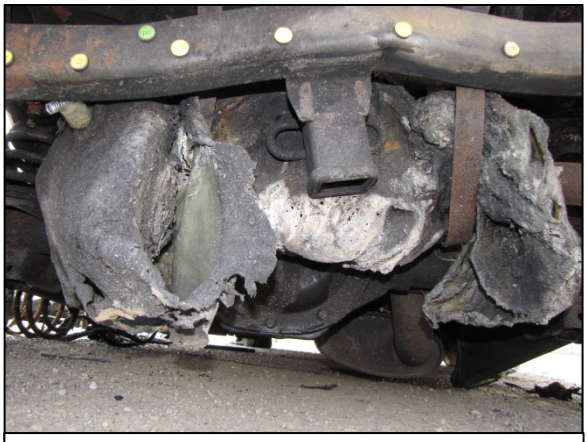


Figure 16. Rear of the ruptured, deformed, and melted fuel tank of the Jeep.

Based on an exemplar vehicle inspection, the HDPE fuel tank was positioned 20 cm (8 in) forward of the back plane bumper beam at the midline location and 6 cm (2.5 in) aft of the rear differential cover. Post-crash, remnants of the melted HDPE fuel tank (**Figure 16**) were resting on the tank straps that remained intact but deformed by the impact.

Trailer Hitch

The trailer hitch was installed by a service center in December 2014 as a remedy to NHTSA Recall No. 13V252000. The Class III-type hitch was constructed of 6 cm (2.5 in) square tubing and formed to fit the contour of the back plane of the Jeep. The overall length of the trailer hitch was 92 cm (36.2 in). Symmetrically formed mounting brackets were welded to both ends of the square tubing and bolted to the rear frame rails with three 12 mm diameter bolts. The two aft bolts were spaced on 13 cm (5 in) centers while the center and forward bolts were on 18 cm (7.25 in) spacing. The mounting brackets were formed from 4.7 mm (3/16 in) plate steel and measured 37 cm (14.75 in) in overall length along the frame rails and were 18 cm (7 in) in height at the location of the square tube. The 38 cm (15 in) center section of the square tubing was straight. Both ends were formed forward 4 cm (1.5 in) with the bend beginning 19 cm (7.5 in) from the centerline. At the mid portion of the trailer hitch, the square tubing was 8 cm (3 in) aft of the HDPE fuel tank while the gap between the tank and the corners of the hitch measured 4 cm (1.5 in).

Figure 17. Undercarriage view of the Jeep's deformed trailer hitch and melted fuel tank.

The 5 cm (2.0 in) receiver sleeve was welded to bottom of the square tube of the hitch. The receiver protruded 13 cm (5.0 in) rearward of the tubing. A plate was welded to the back side of the receiver to cover the edges of the receiver sleeve. There was no ball mount installed in the receiver at the time of the crash. **Figure 17** is an undercarriage view of the Jeep's deformed trailer hitch. **Figure 18** is an undercarriage view of a trailer hitch mounted on an exemplar Jeep Liberty.

Figure 18: Back undercarriage view of the trailer hitch mounted on an exemplar Jeep Liberty.

Manual Restraint Systems

The Jeep was equipped with 3-point continuous loop lap and shoulder seat belts for the five designated seat positions. Based on an exemplar vehicle inspection, the front row seat belt systems were configured with sliding latch plates, adjustable D-rings and rigid buckle stalks. The driver's seat belt retracted onto an emergency locking retractor (ELR) while the front row right was a switchable ELR/automatic locking retractor (ALR).

Inspection of the driver's manual restraint determined that its webbing had been completely consumed by the fire. The latch plate was missing and could not be found. It was not located in the buckle receiver nor at the base of the B-pillar. It could not be definitively determined if the driver was utilizing the seat belt system at the time of the crash. Her restraint status is coded as unknown.

Supplemental Restraint Systems

The Jeep was equipped with the Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front row right occupant positions. The CAC system consisted of dual-stage air bags, seat track positioning sensors, seat belt buckle switches, front row retractor pretensioners, and an occupant classification sensor in the front row right seat cushion.

The driver air bag was exposed from the steering wheel-mounted module due to the fire consuming the polymer cover. The air bag did not appear to have deployed due to the fire and would not have deployed in the rear impact crash. The front row right air bag and its inflator appeared to have been totally consumed by the fire.

2007 JEEP LIBERTY OCCUPANT DATA

Driver Demographics

Age/sex:	58 years/female
Height:	173 cm (68 in)
Weight:	109 kg (240 lb)
Eyewear:	Unknown
Seat type:	Forward-facing bucket seat with integrated head restraint

Seat track position: Mid-to-rear track
Manual restraint usage: Unknown
Usage source: SCI vehicle inspection
Air bags: Front air bag available, not deployed
Alcohol/drug data: None
Egress from vehicle: Body removed by fire fighters/medical examiner
Transport from scene: Body transported to the medical examiner's office for autopsy
Medical treatment: None, fatal at scene

Driver Injuries

Injury No.	Injury	AIS Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Extensive thermal burns and charring resulting in loss of skin and subcutaneous tissue overlying the head, face, neck, arms, chest, abdomen, back, and legs with heat fractures of the bones of the arms	912030.5	Crash-induced fire	Certain
2	Right parietal subdural hemorrhage	140650.3	Integrated head restraint and/or second row seat back	Possible
3	Subgaleal hemorrhage of the parietal and occipital scalp	110402.1	Integrated head restraint and/or second row seat back	Possible
4	Inhalation injury involving soot in larynx and elevated carboxyhemoglobin of 4.8% with pulmonary edema	419200.2	Post-crash fire	Certain
5	T7 vertebral fracture	650416.2	Front row left seat back	Probable
6	T8 vertebral fracture	650416.2	Front row left seat back	Probable

Source: Autopsy Report (Internal).

Driver Kinematics

The 58-year-old female driver of the Jeep was likely seated in an upright driving position while traveling northbound en route to her work place. The remains of the vehicle interior suggested the seat track was in a mid-to-rear position. It is unknown if she was restrained by the manual seat belt system as the webbing was completely consumed by the fire and the latch plate could not be located in the vehicle.

At impact with the Buick (Event 1), the driver initiated a rearward trajectory as she responded to the 6 o'clock impact force. Her back loaded the seat back and partially loaded the left upper aspect of the front row right seat back. She sustained fractured of thoracic vertebrae T7-8 from the seat back loading. The driver's seat back totally collapsed onto the second-row seat cushion. The left aspect of the front row right seat back was deformed rearward from the driver loading, but remained upright.

The right parietal and occipital aspects of the driver's head possibly contacted the head restraint and the second-row seat back causing a right parietal subdural hemorrhage and subgaleal hemorrhage of the parietal and occipital scalp. As the Jeep rotated counterclockwise and struck the traffic light support pole (Event 3), the driver would have been minimally displaced to her right. At this point she was lying on the deformed seat back. The Jeep was struck on the left side by the Buick as the Buick came to rest. This minor severity impact did not alter the position of the driver. The latter events (Events 3 and 4) were not injury-producing.

The rear doors of the Jeep were jammed closed by the exterior deformation. The front doors of the Jeep remained operational; however, both were restricted from opening by the final rest position of the Jeep against the traffic light support and the final rest position of the Buick engaged against the left front door of the Jeep. First responders were unable to remove the driver of the Jeep due to the intensity of the fire. The witnesses stated to the investigating police officer that they could hear the driver of the Jeep calling for help as it appeared she remained conscious following the impact events. She expired in the vehicle due to the fire.

As the fire was extinguished by the firefighters, the investigating officer stated that the driver of the Jeep was found lying on the front row left seat back with her body in the second row toward the centerline of the vehicle. Her body was removed by the firefighters and personnel from the medical examiner's office and transported for autopsy.

The autopsy listed the driver as sustaining extensive thermal burns with charring resulting in skin loss and subcutaneous tissue overlying the head, face, neck, arms, chest and legs with heat fractures of the upper extremities. She also had an inhalation injury involving soot in the larynx and an elevated carboxyhemoglobin of 4.8 percent. Her cause of death was specific to the crash-induced fire.

2003 BUICK CENTURY

Description

The 2003 Buick Century (**Figure 19**) was identified by VIN 2G4WS52J531xxxxxx. The vehicle's date of manufacture is unknown as the placard was concealed by the jammed left front door. The Buick was powered by a 3.1-liter, V-6 gasoline engine linked to a 4-speed automatic transmission with a steering column-mounted shift lever. The front wheel-drive platform was configured on a 277 cm (109.1 in) wheelbase. Standard features included power-assisted, 4-wheel disc brakes with ABS and

Figure 19. Left front oblique view of the Buick.

electronic brakeforce distribution, power-assisted rack-and-pinion steering, and a tilt steering column. The vehicle manufacturer recommended tire size was P205/70R15. At the time of the crash, the Buick was equipped with tires from three different manufacturers. The left front was a Hercules Tour 40 Plus, the left rear and right front were Mastercraft Touring LSR and the right rear was a Firestone FR710. The right rear tire was a P215/70R15. The other three were of manufacturer specifications. All tires were mounted on OEM steel wheels with chrome hubcaps. The right rear hubcap was not installed prior to the crash. The specific tire data at the time of the SCI inspection was as follows:

Position	Tire Identification Number	Measured Tread Depth	Restricted	Damage
LF	KABV B20H xxxx	4 mm (5/32 in)	Yes	Yes, rim deformed
LR	U9YT FWM xxxx	3 mm (4/32 in)	No	No
RR	WBM3 711 xxxx	3 mm (4/32in)	No	No
RF	U9YT FWM xxxx	3 mm (4/32 in)	No	No

The interior of the Buick was configured for seating of six occupants. The front row seat consisted of a split-bench, driver-side wide, that created a center position. A fold-down center armrest formed the center seat back when folded rearward. At the time of the crash it was folded down and used as an armrest. The front row right seat was independent of the driver's seat with a separate track system. Both were manually adjusted. The driver's seat and front row right seat were equipped with adjustable head restraints that were in the full-down positions at the time of the crash. The second row was a fixed bench seat with adjustable head restraints for the left and right positions. Both were adjusted to the full-down positions. All seating surfaces were leather. The manual safety systems consisted of 3-point continuous loop lap and shoulder seat belts for the front row left and right positions and the left and right positions of the second row. Both center seat positions were configured with lap belts. Supplemental restraint was provided by dual-stage frontal air bags for the driver and front row right positions. Both frontal air bags deployed during the Event 1 crash with the Jeep.

Exterior Damage

The Buick sustained underride damage, biased to the left of the front plane from the Event 1 impact with the Jeep (**Figures 20** and **21**). As the Buick engaged the back plane of the Jeep, the hood face of the Buick contacted the Jeep's lift gate-mounted spare tire, compressing the tire and wheel into the lift gate. The direct contact damage of the hood face began 39 cm (15.5 in) right of the centerline and extended 104 cm (41 in) to the left corner of the hood face. As a result, the hood latch striker plate separated from the underside of the hood, allowing the hood to crush rearward. The upper radiator support also engaged the back plane of the Jeep. As the hood

Figure 20. Overhead view depicting the front deformation of the Buick.

was displaced rearward, it buckled at midpoint and struck and penetrated the center and left aspects of the Buick's windshield.

Figure 21. Right lateral view of the Buick.

The front bumper fascia was consumed by the fire; therefore, the direct contact damage was documented at the levels of the bumper beam and the hood face. At bumper level, the direct contact began 19 cm (7.5 in) right of the vehicle's centerline and extended 95 cm (37.5 in) to the left corner. Maximum crush at bumper beam level was 81 cm (31.9 in) located at the left corner. The severity of crush deformed the entire end width of the Buick, resulting in a combined direct and induced damage length 116 cm (45.8 in) at bumper level. A crush profile was documented by the Nikon total station and was as follows: C1 = 81 cm (31.9 in), C2 = 79 cm (31.1 in), C3 = 71 cm (28 in), C4 = 65 cm (25.6 in), C5 = 50 cm (19.7 in), and C6 = 19 cm (7.4 in). The left wheelbase was shortened 27 cm (10.6 in) restricting the left front tire. The CDC assigned to the damage pattern was 12FDEW4. The damage algorithm of the WinSMASH model computed a velocity change of 64 km/h (40 mph) with longitudinal and lateral components of -64 km/h (-40 mph) and 0 km/h, respectively.

The front plane of the Buick engaged the left plane of the Jeep as the Jeep came to rest at the northwest quadrant of the intersection. The specific frontal plane damage was masked by the Event 1 damage and the post-crash fire damage. Based on the damage to the Jeep and the final rest positions of the vehicles, the Event 3 damage to the Buick was to the left and center aspects of the front plane resulting in an estimated CDC of 12FYEW1.

The Buick's post-crash trajectory followed the Jeep; therefore, the Buick was exposed to the fire and the burning fuel from the Jeep. At rest, the front plane of the Buick was exposed to the extensive fire encompassing the Jeep. The fire spread to the frontal plane of the Buick and consumed the polymer components of the exterior and engine compartment. The fire was contained to the engine compartment and did not spread to the interior of the Buick.

Event Data Recorder

The Buick Century was equipped with an air bag control module (ACM) that was mounted beneath the front row right seat. The ACM had event data recorder (EDR) capabilities and was supported by the Bosch Crash Data Retrieval tool. The EDR had the capabilities to record and store one Non-Deployment event, inclusive of pre-crash data. This event could be overwritten by another Non-Deployment event. A stored Non-Deployment event was cleared after 250 ignition cycles. The EDR could record and store two Deployment events, inclusive of pre-crash data, if they occur in five seconds of one another. Deployment or Deployment level events could not be cleared by the EDR. The module was removed during the police investigation by search warrant, imaged, and placed into police evidence prior to SCI's involvement in the investigation. The SCI team could not directly image the module due to the criminal elements of this crash; however, the police provided SCI with an electronic .pdf report of the imaged data. The data was imaged

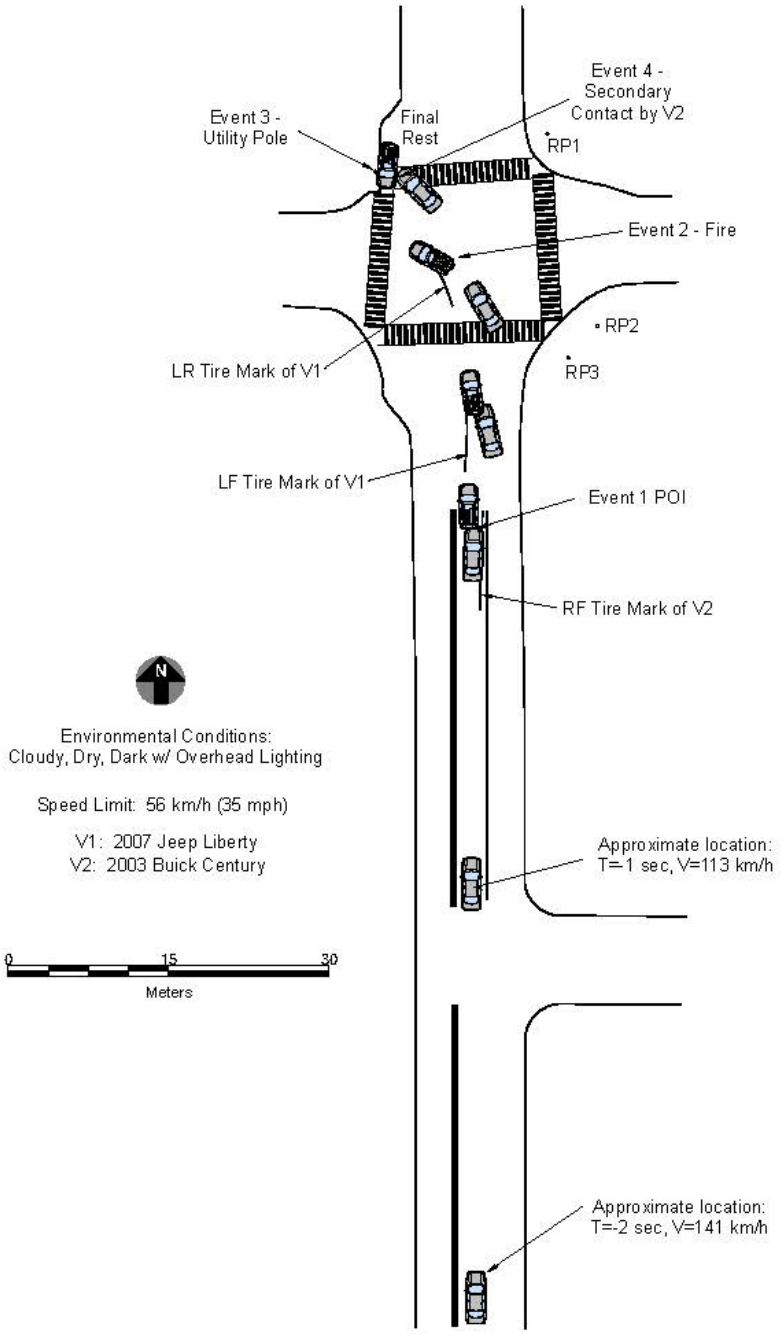
by the police with Bosch CDR software version 17.3 and is attached to the end of this report as **Appendix A**.

The limited data in this model year 2003 EDR file recorded the driver's seat belt system as unbuckled. The maximum longitudinal velocity change was -64.61 (-40.15 mph) at 107.5 ms after AE. As previously discussed, the pre-crash speed of the Buick was recorded at 150 km/h (93 mph) 5 seconds prior to AE and slowed to a recorded speed of 113 km/h (70 mph) 1 second prior to AE. The EDR recorded the driver applying the service brakes 1 second prior to AE. Air bag deployment was commanded at 7.5 ms.

Occupant Data

The 40-year-old female driver of the Buick was not restrained by the manual seat belt system at the time of the crash. She was removed from the vehicle by emergency personnel and transported by ambulance to a local hospital then transferred by helicopter to a regional trauma center with police-reported incapacitating (A-level) injuries.

CRASH DIAGRAM



	NHTSA www.nhtsa.gov
Case Number:	CR17025

APPENDIX A: 2003 Buick Century Event Data Recorder Report[1]

[1] The Bosch CDR Report contained in this technical report was imaged by the investigating police department using the current version of the Bosch CDR software at the time of imaging the EDR. Only a PDF copy the Bosch CDR report was provided by the police and the EDR hexadecimal data has been deleted from the report due to the potential personal identifiable information contained (vehicle identification number, etc.).

BOSCH

CDR CRASH DATA RETRIEVAL

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	2G4WS52J531xxxxxx
User	
Case Number	
EDR Data Imaging Date	09/07/2017
Crash Date	
Filename	
Saved on	Thursday, September 7 2017 at 09:13:09
Imaged with CDR version	Crash Data Retrieval Tool 17.3
Imaged with Software Licensed to (Company Name)	
Reported with CDR version	Crash Data Retrieval Tool 17.3
Reported with Software Licensed to (Company Name)	
EDR Device Type	Airbag Control Module
Event(s) recovered	Deployment

Comments

Data Limitations

Recorded Crash Events:

There are two types of Recorded Crash Events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event may be overwritten by another Non-Deployment Event. This event will be cleared by the SDM, after approximately 250 ignition cycles. This event can be overwritten by a second Deployment Event, referred to as a Deployment Level Event, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds before a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM. The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. If a Deployment Level Event occurs within five seconds after the Deployment Event, the Deployment Level Event will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Longitudinal Velocity Change reflects the change in longitudinal velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Longitudinal Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. For Deployment Events, the SDM will record 100 milliseconds of data after Deployment criteria is met and up to 50 milliseconds before Deployment criteria is met. For Non-Deployment Events, the SDM will record up to the first 150 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.

-SDM Recorded Vehicle Speed accuracy can be affected by various factors, including but not limited to the following:
    -Significant changes in the tire's rolling radius
    -Final drive axle ratio changes
    -Wheel lockup and wheel slip
-Brake Switch Circuit Status indicates the open/closed state of the brake switch circuit.
-Pre-Crash data is recorded asynchronously. The 1.0 second Pre-crash data value (most recent recorded data point) is the data point last sampled before AE. That is to say, the last data point may have been captured just before AE but no more than 1.0 second before AE. All subsequent Pre-crash data values are referenced from this data point.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if:
    -The SDM receives a message with an "invalid" flag from the module sending the pre-crash data
    -No data is received from the module sending the pre-crash data
    -No module present to send the pre-crash data
-Engine Speed is reported at two times the actual value in the following vehicles, if the vehicle is equipped with a 6.6L Duramax diesel engine (RPO LB7, LBZ, LLY, or LMM):
    -2001-2006 Chevrolet Silverado
    -2007 Chevrolet Silverado Classic
    -2001-2006 GMC Sierra
    -2007 GMC Sierra Classic
    -2006-2007 Chevrolet Express
    -2006-2007 GMC Savana
    -2003-2009 Chevrolet Kodiak
    -2003-2009 GMC Topkick
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Driver's Belt Switch Circuit may be reported other than the actual state.
-Passenger Front Air Bag Suppression Switch Circuit Status indicates the status of the suppression switch circuit.
-The Time Between This Event and the Previous Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-If the vehicle is a 2000 - 2002 Chevrolet Cavalier Z24 or a Pontiac Sunfire GT, with a manual transmission (RPO MM5) and a 2.4L engine (RPO LD9), the Brake Switch Circuit Status data will be reported in the opposite state than what actually occurred, e.g. an actual brake switch status of "ON" will be reported as "OFF"
-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 Speed, Engine Speed, and Percent Throttle data are transmitted by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted by either the ABS module or the PCM, via the vehicle's communication network, to the SDM.
-The SDM may obtain Belt Switch Circuit Status data a number of different ways, depending on the vehicle architecture. Some switches are wired directly to the SDM, while others may obtain the data from various vehicle control modules, via the vehicle's communication network.
-The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

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.

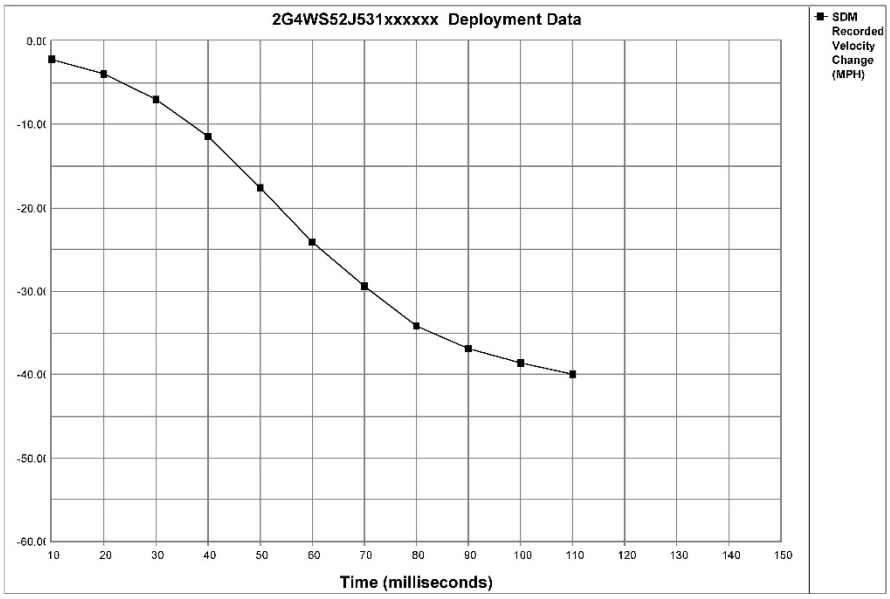
01025_SDMG-99JXZ09-10_r004

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger SIR Suppression Switch Circuit Status (if equipped)	Air Bag Not Suppressed
Ignition Cycles At Deployment	28849
Ignition Cycles At Investigation	28850
Maximum SDM Recorded Velocity Change (MPH)	-40.15
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	107.5
Time Between this Event and the Previous Event (sec)	N/A
Time From Algorithm Enable to Deployment Command Criteria Met (msec)	7.5

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	93	2496	0
-4	91	2240	0
-3	89	2304	20
-2	88	2240	0
-1	70	1792	0

Seconds Before AE	Brake Switch Circuit State
-8	OFF
-7	OFF
-6	OFF
-5	OFF
-4	OFF
-3	OFF
-2	OFF
-1	ON



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	-2.19	-3.95	-7.02	-11.41	-17.55	-24.13	-29.40	-34.23	-36.86	-38.61	-39.93	N/A	N/A	N/A	N/A

Hexadecimal Data

Disclaimer of Liability

The users of the CDR product and reviewers of the CDR reports and exported data shall ensure that data and information supplied is applicable to the vehicle, vehicle's system(s) and the vehicle ECU. Robert Bosch LLC and all its directors, officers, employees and members shall not be liable for damages arising out of or related to incorrect, incomplete or misinterpreted software and/or data. Robert Bosch LLC expressly excludes all liability for incidental, consequential, special or punitive damages arising from or related to the CDR data, CDR software or use thereof.

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of Transportation

**National Highway
Traffic Safety
Administration**

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