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Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team on the date this report was published.

16. Abstract

This report documents the remote investigation of the multiple-event crash of a 2007 BMW 525i that resulted in fatal injuries to a 23-month-old male child secured in forward-facing child restraint system in the second-row left position of the BMW and the post-impact fire that developed in that vehicle. The front and left planes of the BMW struck the right plane of a 2000 Pontiac Firebird that had lost control and crossed the centerline of the road. The crash occurred in June 2012 and was identified by the National Highway Traffic Safety Administration through a records search of the Fatal Analysis Reporting System. Data was obtained from the investigating law enforcement agency and consisted of a detailed crash report, a scaled crash diagram, and on-scene and police-inspection images of the vehicles and the crash site. An event data recorder file imaged from the Pontiac was also reviewed. Additionally, the SCI team interviewed the police reconstructionist and a witness to the crash who assisted the occupants of the BMW at the early on-set of the fire.

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Special Crash Investigations
Remote Child Restraint System Crash Investigation
Case Number: CR17001
Vehicle: 2007 BMW 525i
Location: Alabama
Crash Date: June 2012

BACKGROUND

This report documents the remote investigation of the multiple-event crash of a 2007 BMW 525i (**Figure 1**) that resulted in fatal injuries to a 23-month-old male child secured in a forward-facing child restraint system (CRS) in the second-row left seat of the BMW and the post-impact fire that developed in that vehicle. The front and left planes of the BMW struck the right plane of a 2000 Pontiac Firebird that had lost control and crossed the centerline of the road. The National Highway Traffic Safety Administration's Office of Rulemaking identified the crash through a records search of the Fatal Analysis Reporting System (FARS) due to its interest in crashes with CRS usage and with vehicle fires. NHTSA's Crash Investigation Division subsequently assigned a remote investigation of this crash to the Special Crash Investigation team at Crash Research & Analysis, Inc., in January 2017. A remote level investigation was conducted due to the unavailability of the involved vehicles; the crash occurred in 2012 and the vehicles had been sold. Data was obtained from the investigating law enforcement agency and consisted of a detailed crash report, a scaled crash diagram, and on-scene and police-inspection images of the vehicles and the crash site. An event data recorder (EDR) file was imaged from the Pontiac. Additionally, the SCI team interviewed the police reconstructionist and a witness to the crash who removed the occupants from the BMW at the early on-set of the fire.

Figure 1. Front-left oblique view of the 2007 BMW. (Image provided by the investigating police department.)

The Pontiac was being driven northbound by an unbelted 20-year-old male in a right curve at a high rate of speed. The driver lost control when the Pontiac departed the right road edge and the driver over-corrected with a left steering input. The Pontiac began rotating counterclockwise and crossed the centerline of the two-lane road directly into the path of the southbound BMW. The BMW was driven by a belted 28-year-old male and was occupied by a belted 27-year-old female in the front-row right position and the 23-month-old male secured in a forward-facing CRS in the second row left position. The front plane of the BMW struck the right plane of the Pontiac. The force of the impact redirected the BMW to the northwest and caused the vehicle to begin a clockwise rotation. The BMW departed the west road edge and came to rest facing northwest. The Pontiac overturned and came to rest in the southbound lane. Witnesses to the crash ran to aid the occupants of the BMW. These witnesses removed the BMW driver and its occupants from

the vehicle as a post-impact fire began to develop. The driver and front passenger were transported by ambulance to a hospital with police-reported incapacitating (A- level) injuries. The child, transported by helicopter to a hospital, was admitted and expired the next day. The driver of the Pontiac sustained police-reported, non-incapacitating (B-level) injuries.

SUMMARY

Crash Site

The crash occurred on a two-lane road (**Figure 2**) on a dark night. At the time of the crash, the National Weather Service reported the temperature at 28º C (83º F) with light rain and westerly winds of (6 mph). The asphalt-surfaced roadway curved to the right for northbound traffic and was level. Delineations consisted of a painted centerline that allowed for passing in the northbound direction and painted solid white edge lines. There were no shoulders as the road edges transitioned to cut grass. A tree line bordered the grass roadsides. The posted speed limit was 89 km/h (55 mph). An approximate crash diagram, developed from the police crash report information, is included at the end of this technical report.

Figure 2. North-facing view of the crash site. (Image provided by the investigating police department.)

Pre-Crash

The BMW was occupied by the two adults seated in the front row and the 23-month-old male restrained in a forward-facing CRS in the second row left position. The BMW was traveling south at a witness-estimated speed of 64 km/h (40 mph) as he negotiated the left curve.

The police reported that the driver of the Pontiac was socializing with family and friends during the day and evening hours leading up to the crash time. He was intoxicated with a police-reported BAC of .106 g/dl. The 20-year-old left the gathering and traveled north on the two-lane road.

A witness and his cousin were talking on the front porch of a residence and heard the Pontiac approach with the sound of a loud engine. As they heard the northbound Pontiac, the male witness estimated the vehicle's speed at 145 km/h (90 mph) as it passed their location. The witness stated to his cousin that at that speed, the vehicle would not be able to track through the impending right curve. The EDR-recorded speed of the Pontiac was 150 km/h (93 mph) 5 seconds prior to algorithm enable (AE).

As the Pontiac entered the right curve, it drifted onto the right roadside. The police reconstructionist identified right-side tire marks from the Pontiac on the grass roadside. The driver of the Pontiac applied a counterclockwise steering input in an attempt to regain the travel lane. The police documented a counterclockwise arcing tire mark on the asphalt road surface as the vehicle lost traction and began a counterclockwise yaw.

The Pontiac yawed approximately 120 degrees counterclockwise from its initial northbound heading as it crossed the centerline into the southbound lane. Based on the length and curvature of the yaw mark, speed calculations completed by the police computed a vehicle speed of 118 km/h (73 mph) as the Pontiac entered the southbound lane. The EDR-recorded speed of the Pontiac was 97 km/h (60 mph) at the 2-second and 1-second intervals prior to AE with the brake switch recorded as "ON."

The driver of the BMW stated to the investigating officer that when he detected the Pontiac encroach into his lane, the vehicle was out-of-control in a sideways motion. The BMW driver reported that he steered to the right in an attempt to avoid the crash.

Crash

The front plane/left aspect of the BMW initially struck the right plane of the Pontiac at its A-pillar area, resulting in an 11/4 o'clock impact configuration (Event 1). The force of the impact halted the southbound momentum of the BMW. As the vehicles crushed to maximum engagement, the direct and induced damage extended across the entire front plane of the BMW and involved an estimated 51 cm (20 in) of structural crush at the bumper beam. The left frame rail of the BMW was displaced rearward and laterally right. The bumper beam separated from the right frame rail. The BMW's left front tire and wheel engaged the right plane of the Pontiac, separating the suspension and axle rearward and right. As the BMW penetrated into the side structure of the Pontiac, the left upper A-pillar contacted the matching component of the Pontiac. The momentum of the Pontiac displaced the BMW rearward and the vehicles began to rotate CW during their engagement. The left plane of the BMW and the right plane of the Pontiac struck in a side-slap configuration (Event 2). The resulting force directions were in the 9 o'clock sector for the BMW and 3 o'clock sector for the Pontiac. The severity of the crash appeared to have been sufficient to result in frontal and (left) side impact air bag deployments in the BMW. However, due to the consequence of the post-crash fire, air bag deployment is coded as unknown. The Pontiac's frontal air bags deployed in the crash.

The BMW came to final rest approximately 24 m (80 ft) northwest of the initial point of impact facing northwest. The Pontiac rotated counterclockwise on the road surface and tripped into a rollover event (Event 3). At final rest, the Pontiac was on its right plane approximately 24 m (80 ft) north of the impact facing northwest. Due to the remote nature of this investigation and the limited images of the vehicle, the specifics of the rollover could not be determined. During the rollover, the unbelted driver of the Pontiac was completely ejected from the vehicle, possibly through the left roof opening, the area of the removable roof panels.

Post-Crash

After hearing the sound of the impact, the witnesses ran and immediately checked the condition of the occupants of the BMW. A post-crash fire was observed to be developing in the vehicle. The male witness opened the right front door and assisted the female passenger from the BMW. He then reached over the interior and pulled the driver from the vehicle. Both occupants were placed on the grassy area away from the BMW. Next, the male witness opened the right rear door of the BMW and removed the child occupant from the forward-facing CRS. The CRS was left in the vehicle and subsequently burned. These witnesses and the witness that was following behind the BMW used their cell phones to notify the emergency response center of the crash and

its severity. Police, firefighters, and emergency medical services responded to the crash site. The front row occupants of the BMW were transported by ambulance to a local hospital where they were admitted for treatment of police-reported A-level injuries. The child occupant of the BMW was transported by helicopter to a regional trauma center where he was admitted. He expired from his injuries the next day. His body was transferred to the medical examiner for autopsy. It should be noted that the child occupant did not sustain any thermal injury or burns from the crash. The ejected driver of the Pontiac was transported by ambulance to a local hospital where he was admitted for treatment of his injuries.

Firefighters extinguished the fire in the BMW. The vehicles were removed by a local tow service and transported to the police impound pending the conclusion of the criminal investigation.

2007 BMW 525i

Description

The 2007 BMW 525i 4-door sedan was identified by Vehicle Identification Number (VIN) WBANE53567Cxxxxxx. The vehicle was powered by a 3.0 liter inline 6-cylinder gasoline engine with rear wheel drive. Specifications for this vehicle identified the following standard equipment: speed proportional power-assisted steering, power-assisted four-wheel disc brakes with ABS, electronic brakeforce distribution, emergency braking preparation, electronic stability control, traction control, and a tire pressure monitoring system. The manufacturer recommended tire size was P225/50R17. The police report identified the tires at the time of the crash as Continental Ecoplus Contouring Contact all-season radials, sized at P225/50R17. The specific tread depth and tire pressures were not recorded. The tires were mounted on OEM 5-spoke alloy wheels.

Figure 3. Front-plane damage to the 2007 BMW. (Image obtained from an online VIN source.)

The interior of the BMW was configured for seating of five occupants (2/3) with front row bucket seats and a second-row bench seat with a center fold-down armrest. The driver and front row right seats were 10-way power adjustable. All five seat positions were equipped with adjustable head restraints. Due to the post-crash fire, the specific adjusted positions of the head restraints at the time of the crash are unknown. Manual safety systems consisted of continuous loop 3-point lap and shoulder belts for the five designated positions. The front row safety belt systems were configured with buckle pretensioners. Supplemental restraint was provided by dual-stage, 208-certified advanced compliant (CAC) frontal air bags for the driver and front passenger positions, front door-mounted side impact air bags, and side impact sensing roof side rail-mounted inflatable curtain (IC) air bags that provided coverage for both rows. The second row was equipped with lower anchors and tethers for children (LATCH).

Exterior Damage

The exterior of the BMW sustained damage to the front and left planes (**Figure 3** and **4**) from the impacts with the Pontiac. The initial contact originated at the front left area and extended across the front plane as the BMW penetrated into the right plane of the Pontiac. The direct contact damage (Event 1) appeared to have spread to the left and center regions of the front plane, crushing the bumper beam to an estimated depth of 51 cm (20 in) at the left corner. Continued crushing into the right plane of the Pontiac caused the left upper A-pillar of the BMW to engage the right upper A-pillar of the Pontiac. The collision deformation classification (CDC) for the Event 1 damage was 11FYAW6.

Figure 4. Left plane Event 2 damage to the BMW. (Image obtained from an online VIN source.)

As the vehicles crushed, the Pontiac continued to rotate counterclockwise, causing the left plane of the BMW to engage the right plane of the Pontiac (Event 2). The direct contact damage extended across both left side doors, the left roof side rail, onto the left quarter panel (Figure 4) to the back corner of the left plane. The lateral component of this engagement deflected the left rear axle laterally right. Both left doors were jammed closed and intruded. The CDC for the side-slap Event 2 impact was 09LZAW3.

The post-crash fire (Event 4) appeared to have originated in the back-right corner of the BMW (**Figure 5**) near the fuel filler. The fire spread forward to the occupant compartment and consumed all combustible materials of the interior, inclusive of the CRS, seats, door panels and air bags. Due to the limited images and the remote nature of this investigation, the specific origin and cause of the fire is undetermined.

Figure 5. Back-right oblique view of the BMW and the suspected origin of the fire. (Image obtained from an online VIN source.)

Interior Damage

The interior of the BMW sustained intrusion of the occupant compartment from the engagement with the Pontiac. Due to the limited images available to the SCI team, intrusion values were estimated from the police images. The maximum intrusion occurred at the left B-pillar, resulting in approximately 20 cm (8 in) of lateral intrusion into the driver and second row left seat positions. Also intruded in the driver space was longitudinal displacement of the left upper A-pillar 15 cm (6 in). The left front door intruded laterally approximately 15 cm (6 in) with an equal amount of lateral intrusion of the left rear door. The crash-induced fire consumed the interior of the BMW (**Figures 6** and **7**).

The BMW was manufactured with an AS1 laminated windshield that was bonded in the greenhouse framing, powered AS2 door glazing, fixed AS2 rear door quarter windows, a fixed AS2 backlight, and an AS3 operable roof window. Exterior deformation to the BMW displaced the left side structure and buckled the roof resulting in glazing. The windshield was probably fractured by displacement of the deformation of the left upper A-pillar. The post-crash fire destroyed the windshield with its remnants resting on the upper instrument panel. The right-side glazing disintegrated in the fire.

Figure 6. Left plane view of the BMW's interior. (Image obtained from an online VIN source.)

Manual Restraint Systems

Manual restraint systems of the BMW consisted of continuous-loop, 3-point lap and shoulder seat belts for the five seat positions. All systems were configured with sliding latch plates. Based on manufacturer's specifications, the driver's seat belt retracted onto an emergency locking retractor (ELR) while the remaining four retractors were ELR/automatic locking retractors (ALR). Both front systems were configured with adjustable D-rings. The front row was equipped with seat belt buckle pretensioners. The post-crash fire consumed the seat belt systems.

Figure 7. Fire damage to the front row of the BMW. (Image obtained from an online VIN source.)

Supplemental Restraint Systems

The BMW was configured with six air bags consisting of dual-stage CAC frontal air bags for the driver and front passenger, front-door-mounted side impact and roof side-rail-mounted IC air bags that provided protection to the first and second rows. Based on the available police supplied images, a portion of the left IC air bag remained visible, extending from the left front door window opening, thus indicating this air bag probably deployed during the crash. The deployment of the remaining air bags during the crash is unknown as the fire consumed the interior of the BMW. Both the driver's and passenger's frontal air bag inflators are exposed as the concealing vinyl components burned away.

2007 BMW 525i OCCUPANTS

Driver Demographics

Age/sex:	28 years/male
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown

Seat type:	Forward-facing bucket seat
Seat track position:	Unknown
Manual restraint usage:	3-point lap and shoulder seat belt
Usage source:	PAR
Air bags:	Front, door-mounted, and IC air bags available, unknown if deployed
Alcohol/drug data:	Not tested
Egress from vehicle:	Assisted from vehicle by a witness
Transport from scene:	Ambulance to a regional trauma center
Medical treatment	Hospitalized

Driver Injuries

The driver of the BMW was transported by ambulance to a regional trauma center where he was admitted for treatment of his injuries. The hospital would not release the driver's medical records without a patient-signed medical authorization. The driver and front row right occupant of the BMW did not respond to SCI requests for an interview or completion of the medical authorizations.

Driver Kinematics

It was reported by the police that the driver was using the vehicle's manual 3-point lap and shoulder seat belt system. Based on the exterior damage to the BMW, the driver would have responded to the crash forces by moving forward and to his left. The left front door and frontal structure intruded into his occupant space. Initially, the driver would have loaded the manual seat belt system with his torso and pelvic regions. His left side would have contacted the intruding left door and his lower extremities probably contacted the intruding left lower instrument panel. Supplemental occupant protection would have been provided by the deployment of the driver's frontal air bag, the left door-mounted side impact air bag, and the left IC air bag.

The driver came to rest in his occupant position. His door was jammed closed by deformation. Post-crash, a witness ran to the crash site and opened the right front door and pulled the driver from the vehicle through the right front door. The driver was subsequently treated at the scene of the crash by the responding EMS personnel and transported by ambulance to a regional trauma center where he was admitted for treatment of his injuries.

Front-Row Right Occupant Demographics

Age/sex:	27 years/female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat type:	Forward-facing bucket seat
Seat track position:	Unknown
Manual restraint usage:	3-point lap and shoulder seat belt
Usage source:	PAR
Air bags:	Front, door-mounted, and IC air bags available, unknown if deployed
Alcohol/drug data:	Not tested
Egress from vehicle:	Assisted from vehicle by a witness

Transport from scene:	Ambulance to a regional trauma center
Medical treatment:	Hospitalized

Front-Row Right Occupant Injuries

The front-row right occupant was transported by ambulance to a regional trauma center where she was admitted for treatment of her injuries. The hospital would not release the occupant's medical records without a patient-signed medical authorization. The driver and front row right occupant of the BMW did not respond to SCI requests for an interview or completion of the medical authorizations.

Front-Row Right Occupant Kinematics

The front-row right occupant was police-reported as restrained by the vehicle's 3-point lap and shoulder seat belt system. Based on the exterior damage to the BMW, the front-row right occupant would have initiated a forward and left trajectory in response to the crash forces. She would have loaded the manual seat belt system, the center console, and possibly the driver. It is unknown if the frontal or side impact air bags deployed for this occupant. Her specific injuries are unknown.

Post-crash, a witness to the crash ran to the crash site and opened the right front door and removed the front row right occupant from the vehicle. EMS personnel responded to the crash site and evaluated the occupant. She was placed on an ambulance stretcher and transported by ambulance to a regional trauma center where she was admitted for treatment of her injuries.

Second-Row Left Occupant Demographics

Age/sex:	23 months/male
Height:	86 cm (34 in)
Weight:	13 kg (28 lb)
Eyewear:	None
Seat type:	Forward-facing CRS secured to a fixed bench
Seat track position:	Not adjustable
Manual restraint usage:	5-point harness system of the CRS
Usage source:	PAR, witness interview
Air bags:	Left IC air bag available, unknown if deployed
Egress from vehicle:	Removed from vehicle by a witness
Transport from scene:	Helicopter to a regional trauma center
Medical treatment:	Admitted, expired the following day

Second-Row Left Occupant Injuries

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
1	Subdural hemorrhage (20 milliliters)	140652.4	Isolated IPC Left - Intruding left rear door panel	Possible

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
2	Cerebrum contusions in frontal and temporal lobes, predominantly left	140612.3	Isolated IPC Left - Intruding left rear door panel	Possible
3	Swollen cerebrum; ventricle system mildly compressed	140662.3	Isolated IPC Left - Intruding left rear door panel	Possible
4	Subarachnoid hemorrhage (patchy); patchy parenchymal hemorrhages	140693.2	Isolated IPC Left - Intruding left rear door panel	Possible
5	Sphenoid skull fracture	150200.3	Isolated IPC Left - Intruding left rear door panel	Possible
6	Frontal, left temporal, and parietal skull fractures	150400.2	Isolated IPC Left - Intruding left rear door panel	Possible
7	Patchy maroon subscapular contusions	110402.1	Isolated IPC Left - Intruding left rear door panel	Possible
8	1/4 x 1/8” red-brown abrasion on right parietal scalp	110202.1	Unknown	Unknown
9	1 x 1/16” sutured laceration on left aspect of forehead	210602.1	Isolated IPC Left - Intruding left rear door panel	Possible
10	3/8 x 1/16” sutured laceration on left eyebrow	210602.1	Isolated IPC Left - Intruding left rear door panel	Possible
11	2 x 1” blue contusion on left aspect of forehead; 2 x 1” blue contusion on central forehead	210402.1	Isolated IPC Left - Intruding left rear door panel	Possible
12	1 ¼ x ¾” blue ecchymosis on upper and lower eyelids of right eye	210402.1	Isolated IPC Left - Intruding left rear door panel	Possible

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
13	2 x 1” purple ecchymosis on upper and lower eyelids of left eye	210402.1	Isolated IPC Left - Intruding left rear door panel	Possible
14	A few red-brown abrasions, measuring up to 1” in greatest dimension cover forehead in area measuring 3 x 2” and 1 ½ x ¼”	210202.1	Isolated IPC Left - Intruding left rear door panel	Possible
15	A few red-brown abrasions, measuring up to 3/8” in greatest dimension cover an area of the left aspect of face measuring 1 ¼ x 3/8”	210202.1	Isolated IPC Left - Intruding left rear door panel	Possible
16	Patchy alveolar hemorrhages of lungs	441410.3	Isolated IPC Left - Intruding left rear door panel	Possible
17	Fracture of left clavicle	750500.2	Isolated Interior - Child safety seat harness system	Possible
18	Soft tissue hemorrhage over left clavicle	710402.1	Isolated Interior - Child safety seat harness system	Possible
19	Patchy blue contusions, measuring up to 1 ¼” in greatest dimension cover an area of upper left chest, measuring 3 x 1”	410402.1	Isolated Interior - Child safety seat harness system	Possible
20	Scattered red-brown abrasions, measuring up to 1” in greatest dimension cover an area of upper left chest measuring 3 x 1”	410202.1	Isolated Interior - Child safety seat harness system	Possible
21	A 5/8 x 1/8” red-brown abrasion is on central chest	410202.1	Isolated Interior - Child safety seat harness system	Possible

Injury No.	Injury	Injury Severity AIS 2015	Involved Physical Component (IPC)	IPC Confidence Level
22	Fracture of left tibia	854000.2	Isolated IPC Left - Intruding left rear door panel	Possible
23	Fracture of left fibula	854441.2	Isolated IPC Left - Intruding left rear door panel	Possible
24	A ½ x 3/8" pink contusion is on anterior right leg; a 1 ¼" diameter purple contusion is on anterior right leg	810402.1	Isolated IPC Left - Intruding left rear door panel	Possible
25	A few patchy pink contusions, measuring up to ¾" in greatest dimension cover an area of the anterior left leg measuring 1 ¼ x 1"	810402.1	Isolated IPC Left - Intruding left rear door panel	Possible
26	A ½ x ¼" red-brown abrasion on the right knee	810202.1	Isolated IPC Left - Intruding left rear door panel	Possible
27	A few linear red-brown abrasions, measuring up to 3" in length over an area of the left arm measuring 3 x 2"	710202.1	Isolated IPC Left - Intruding left rear door panel	Possible

Source: autopsy report.

Second-Row Left Child Occupant Kinematics

The 23-month-old child occupant was seated in a forward-facing CRS and restrained by the integral 5-point harness system. Due to the post-crash fire that consumed the CRS, this investigation was unable to determine the CRS type, installation, and tautness of the harness system. The witness who ran to the crash site and removed the child occupant from the vehicle stated during the SCI interview that he unbuckled the 5-point harness system of the CRS. This is the sole source to confirm CRS and harness system use.

The child would have responded to the crash forces by moving forward and to his left and loaded the integral harness system of the CRS with his torso and pelvic region. The autopsy report identified multiple abrasions of the child's chest that were possibly related to his loading of the harness system. He also sustained a fracture of the left clavicle with soft tissue hemorrhaging of the clavicle region. This injury may have been related to the loading of the CRS harness straps or resulted from lateral loading of the intruding left rear door panel.

As the BMW engaged the Pontiac, the left plane of the BMW crushed laterally resulting in intrusion of the left doors and pillars. The intruding left rear door panel probably engaged the left aspect of the CRS. The child occupant responded to the lateral component of the crash forces and possibly loaded the intruding door panel with his head resulting in soft tissue abrasions of the face and forehead and underlying fractures of the skull and injuries of the brain.

The child sustained fractures of the left tibia and fibula from possible contact with the intruding door panel. He also sustained multiple soft tissue leg injuries from possible door panel contact.

Immediately following the crash, the male witness ran to the crash site and opened the right-side doors to remove the occupants of the BMW. He stated that he unbuckled the 5-point harness system of the CRS and removed the child occupant from the CRS and the vehicle. This effort was ongoing as he observed a small fire with smoke around the BMW. At the time of occupant removal, the fire was confined to the exterior of the vehicle and had not spread to the occupant compartment. The child occupant did not sustain thermal burn or inhalation injuries.

He was transported by helicopter to a regional trauma center where he was evaluated and admitted for his injuries. The child occupant expired the day following the crash.

2000 PONTIAC FIREBIRD

Description

The 2000 Pontiac Firebird two-door coupe was a rear-wheel drive platform identified by the VIN 2G2FS22K2Y2xxxxxx. The vehicle was configured with T-tops, removable roof panels above the front row seat positions. The powertrain consisted of a 3.8 liter, V-6 gasoline engine linked to a 4-speed automatic transmission with a console-mounted shifter. The service brakes were power-assisted 4-wheel disc with ABS. At the time of the crash, the Pontiac was equipped with Cooper Cobra radial tires on the front axle and Mastercraft Avenger tires on the rear axle. All tires were mounted on 5-spoke alloy wheels and were police-reported as size P235/55R16. The specific tire pressure and tread depths were not reported.

The interior of the Pontiac was configured for seating of four occupants with front row bucket seats and second row split seats separated by the transmission tunnel. Standard equipment safety systems included 3-point lap and shoulder seat belts for the front row and manual lap belts for the two second row seat positions. Single stage frontal air bags were standard equipment for the driver and front passenger positions. Both frontal air bags deployed in this crash.

Exterior Damage

The Pontiac rotated counterclockwise into the path of the BMW and was struck on its right plane by the front plane the BMW (Event 1). Based on the available police images, the damage began at the right A-pillar area of the front fender and right door. Maximum crush was located in the area of the right door and appeared to be uniform from the A-pillar to the B-pillar locations, estimated at 64 cm (25 in). The impact separated the exterior door panel and jammed the right door in the closed position. A-pillar displacement fractured the windshield. The estimated CDC assigned to this damage pattern was 03RYAW4.

As the vehicles crushed to maximum engagement, the Pontiac continued to rotate counterclockwise and its right plane struck the left plane of the BMW in a side-slap configuration (Event 2). The damage continued rearward involving the B-pillar, the right rear tire and wheel and the right quarter panel. The CDC assigned to this damage was 03RZAW4.

Following separation from the BMW, the Pontiac continued to rotate counterclockwise and tripped into a rollover event (Event 3). There were insufficient images of the Pontiac to determine the specifics of the rollover. At rest, it was on its right plane facing in a northwesterly direction in the southbound travel lane. The CDC for this Event 3 rollover was 00RDAO99 with 9's representing unknown values. **Figures 8** and **9** represent the exterior damage to the Pontiac.

Figure 8. Front-right oblique view of the Pontiac. (Image obtained from the investigating police agency.)

Figure 9. Right-plane deformation to the Pontiac. (Image obtained from the investigating police agency.)

Event Data Recorder

The Pontiac was equipped with a sensing and diagnostic control module that had EDR capabilities. The EDR was capable of recording a single non-deployment event and two deployment Events. A non-deployment event records data but does not deploy the vehicle's frontal air bags and contains pre-crash and crash data. A non-deployment event can be cleared from the SDM after 250 ignition cycles or can be overwritten by another non-deployment event. A deployment event also contained pre-crash and crash data. Deployment events cannot be overwritten or cleared by the SDM.

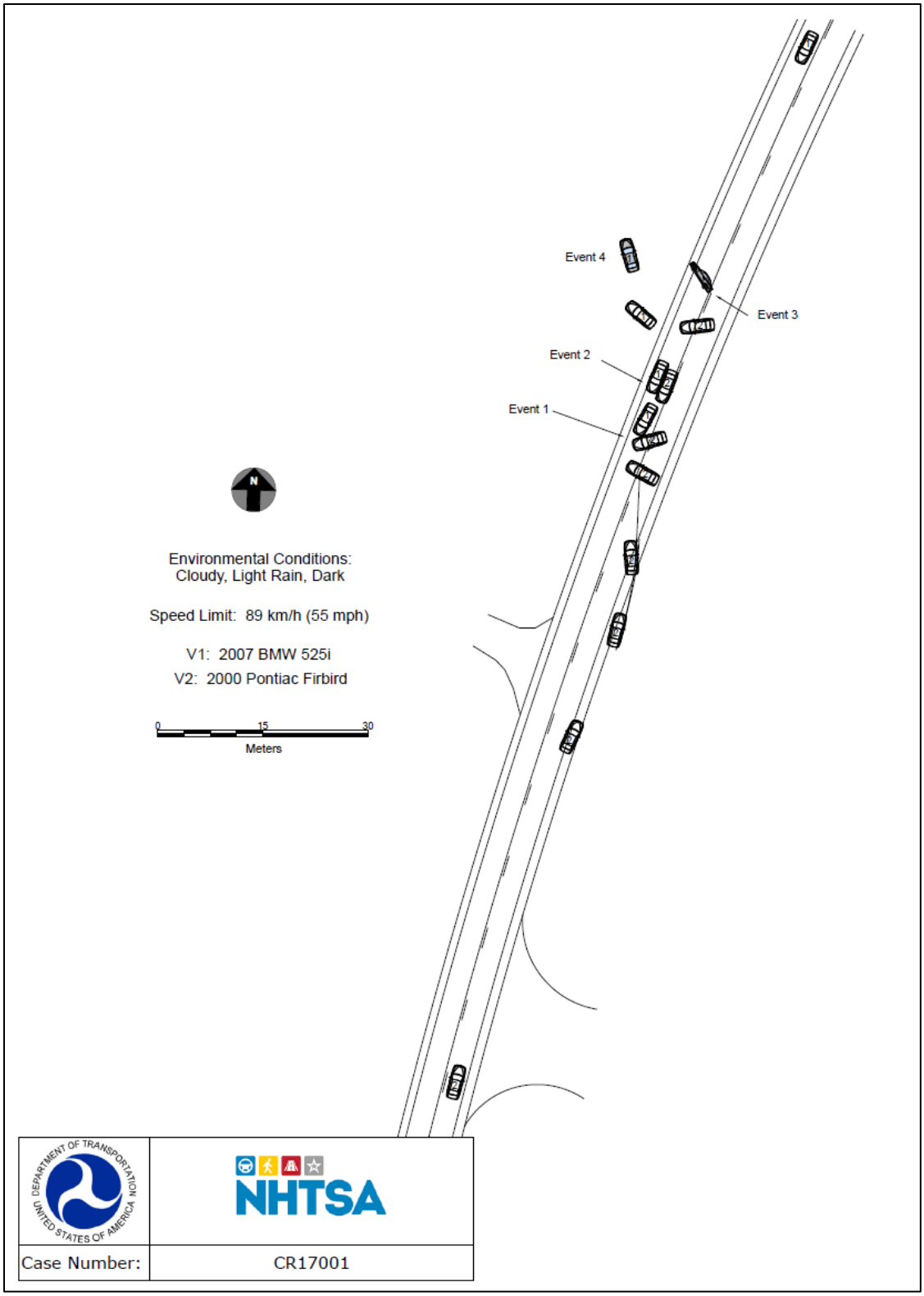
The investigating police reconstructionist imaged the Pontiac's SDM during the course of his investigation using the Bosch Crash Data Retrieval tool and software version 3.5. A hard copy of this report was obtained by the SCI team for this remote investigation and is included at the end of this report as **Appendix A**. The EDR recorded a deployment event and a non-deployment event. Based on the ignition cycles, the non-deployment event occurred 22 ignition cycles prior to the deployment event; therefore, it was not related to this crash. The deployment event file recorded the driver's seat belt switch status as "Unbuckled" and the air bag warning lamp status as "OFF" at the time of the crash. The vehicle's pre-crash data is provided in the table on the following page.

Seconds Prior to AE	Vehicle Speed km/h (mph)	Engine Speed RPM	Brake Switch Circuit Status	Percent Throttle
-5	150 (93)	2752	OFF	0
-4	146 (91)	2496	OFF	0
-3	119 (74)	1984	OFF	0
-2	97 (60)	2176	ON	0
-1	97 (60)	2176	ON	0

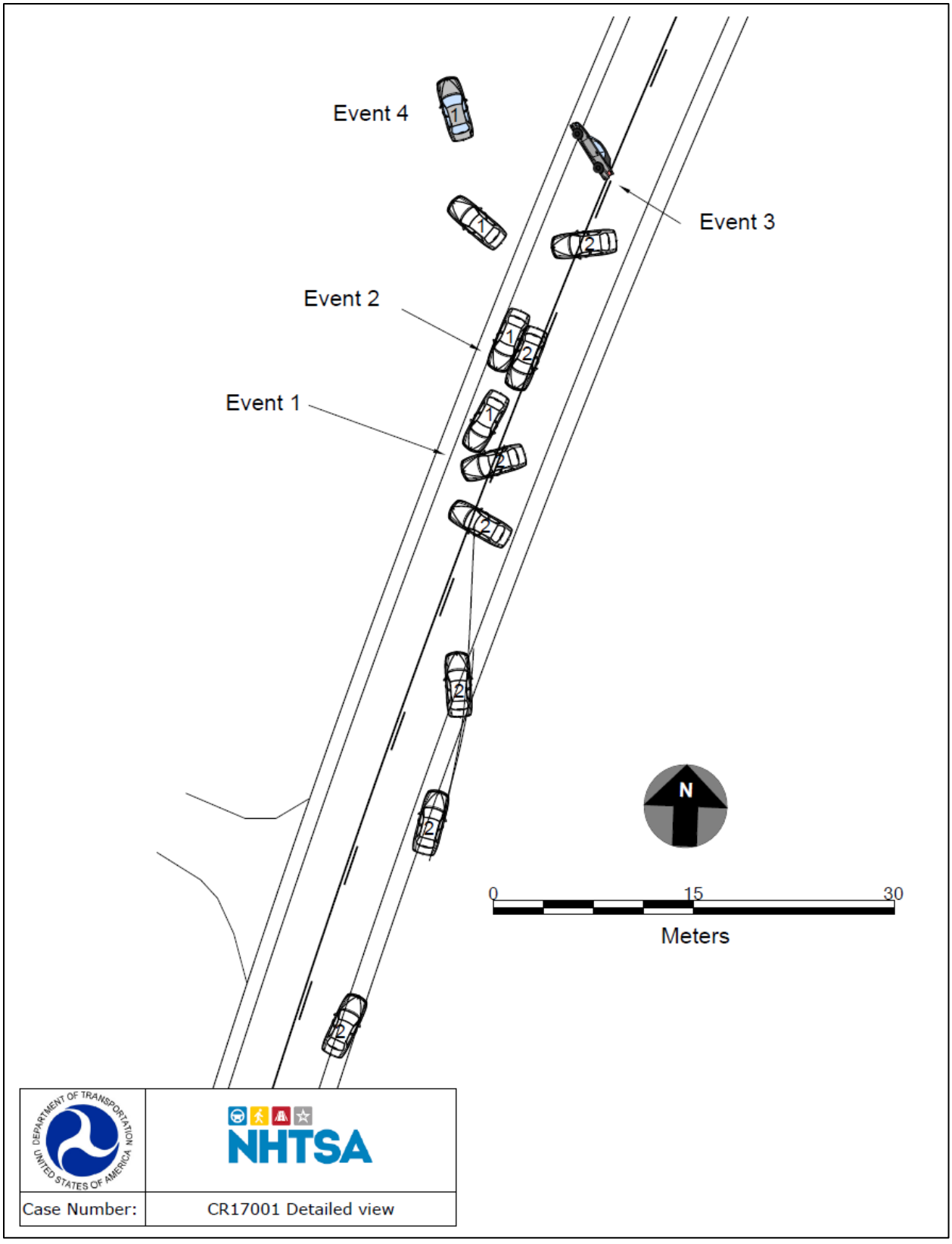
Pontiac Occupant

The Pontiac was operated by an unbelted 20-year-old male. The police reported that he was ejected from the vehicle during the crash sequence and sustained non-incapacitating (B-level) injuries. Through the course of the police investigation, it was determined that the driver was alcohol-impaired at the time of the crash.

CRASH DIAGRAM



CRASH DIAGRAM: A Detailed View



APPENDIX A: 2000 Pontiac Firebird Event Data Recorder Report[1]

[1] The Bosch CDR report contained in this technical report was imaged by the investigating law enforcement agency using the current version of the Bosch CDR software at the time of imaging the EDR. Only an electronic (pdf) file of the Bosch CDR report was provided by the law enforcement agency, and the EDR hexadecimal data has been deleted from the report due to potential personal identifiable information (i.e., vehicle identification number) contained within the report.

BOSCH

CDR CRASH DATA RETRIEVAL SYSTEM

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	2G2FS22K2Y2
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	
Saved on	
Collected with CDR version	Crash Data Retrieval Tool 3.5
Reported with CDR version	Crash Data Retrieval Tool 3.5
EDR Device Type	airbag control module
Event(s) recovered	Deployment Non-Deployment

Comments

No comments entered.

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 cycle. 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 anotherIf 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 Adjusted Algorithm Longitudinal Velocity Change:

Once the crash data is downloaded, the CDR tool mathematically adjusts the recorded algorithm longitudinal velocity data to generate an adjusted algorithm longitudinal velocity change that may more closely approximate the longitudinal velocity change the sensing system experienced during the recorded portion of the event. The adjustment takes place within the downloading tool and does not affect the crash data stored in the SDM, which is displayed in hexadecimal format. The SDM Adjusted Algorithm Longitudinal Velocity Change may not closely approximate what the sensing system experienced in all types of events. For example, if a crash is preceded by other common events, such as rough road, struck objects, or off-road travel, the SDM Adjusted Algorithm Longitudinal Velocity Change may be less than and some times significantly less than the actual longitudinal velocity change the sensing system experienced. 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 metVelocity 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.

-Some of the Pre-Crash data may be recorded after Algorithm Enable (AE). If this occurs, it may affect the reported pre-crash data values, but does not affect other data such as SDM Adjusted Algorithm Longitudinal Velocity Change.
-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 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.

BOSCH

CDR CRASH DATA RETRIEVAL SYSTEM

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	11561
Time Between Non-Deployment And Deployment Events (sec)	N/A

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	93	2752	0
-4	91	2496	0
-3	74	1984	0
-2	60	2176	0
-1	60	2176	0

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

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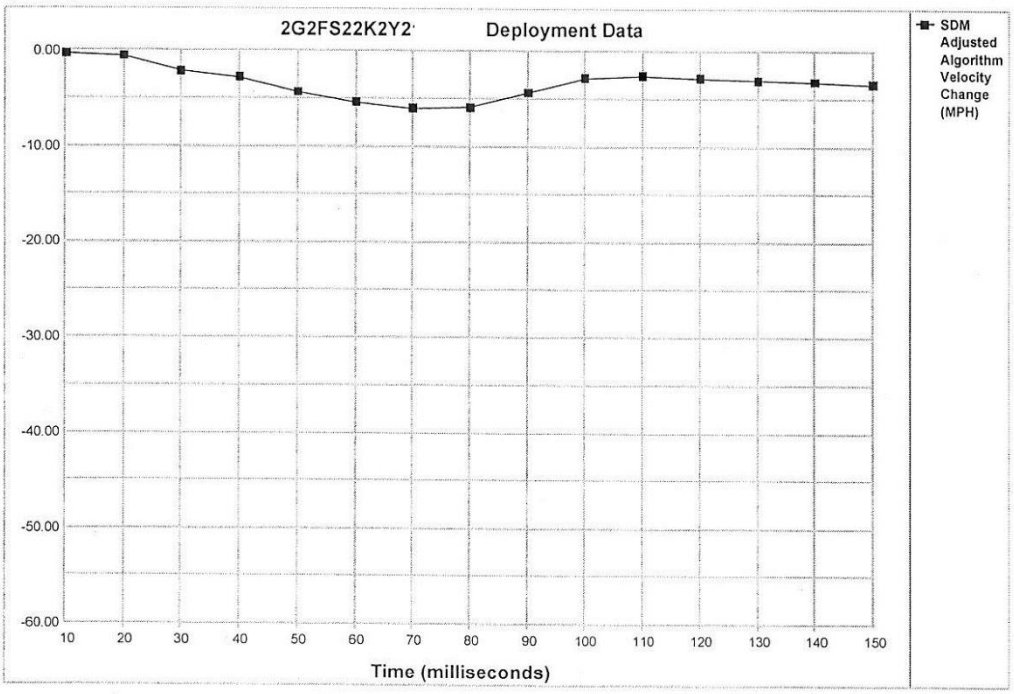
CDR CRASH DATA RETRIEVAL SYSTEM



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Adjusted Algorithm Velocity Change	-0.31	-0.53	-2.06	-2.72	-4.26	-5.36	-6.02	-5.80	-4.26	-2.73	-2.51	-2.73	-2.95	-3.17	-3.39

BOSCH

CDR CRASH DATA RETRIEVAL SYSTEM

System Status At Non-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 Non-Deployment	11539
Maximum SDM Algorithm Longitudinal Velocity Change (MPH)	-0.03

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	33	2048	20
-4	35	2112	5
-3	35	1472	0
-2	32	1024	0
-1	26	832	0

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

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U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

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