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Special Crash Investigations On-Site Guardrail End Treatment Crash Investigation Vehicle: 2004 Pontiac Sunfire Location: Missouri Crash Date: May 2017

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15. Supplementary Note An investigation of a Softstop end terminal impact by a 2004 Pontiac Sunfire. Each crash represents a unique sequence of events, and generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicles or their safety systems. This report and associated case data are based on information available to the Special Crash Investigation team.			
16. Abstract This report documents the on-site investigation of the Softstop end terminal impact of a 2004 Pontiac Sunfire driven by a 71-year-old female. The Pontiac was traveling south on a limited-access roadway and exited onto a single-lane on-ramp that led to an intersecting limited-access roadway. While proceeding along the on-ramp, the Pontiac departed the left side of the roadway and struck the end terminal and guardrail. The Pontiac separated from this impact, crossed the travel lane, and then struck the guardrail on the opposite roadside. The driver of the vehicle sustained reported minor injuries in the crash and was transported by ambulance to a local hospital for treatment.			
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TABLE OF CONTENTS

Special Crash Investigations
Case No.: CR17010
On-Site Guardrail End Treatment Crash Investigation
2004 Pontiac Sunfire
Location: Missouri
Crash Date: May 2017

BACKGROUND

This report documents the on-site investigation of the Softstop end terminal impact of a 2004 Pontiac Sunfire driven by a 71-year-old female. The crash was identified by the Missouri Department of Transportation (MoDOT), which in turn submitted notification to the Federal Highway Administration (FHWA). The FHWA determined that the crash type and guardrail end treatment met the criteria for further research and subsequently forwarded the notification to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration in May 2017. The CID assigned an on-site investigation of the crash to the Special Crash Investigations (SCI) team at Crash Research & Analysis, Inc., on the same day. The SCI team initiated contact with the MoDOT to conduct an on-site investigation in May 2017.

Figure 1: South-facing view of the crash site.

The Pontiac was reportedly traveling south on a limited-access roadway and exited onto a single-lane on-ramp that led to an intersecting limited-access roadway. While proceeding along the on-ramp, the Pontiac departed the left side of the roadway and struck the end terminal and guardrail (**Figure 1**). The Pontiac separated from this impact, crossed the travel lane, and then struck the guardrail on the opposite roadside. The driver of the vehicle sustained reported minor injuries in the crash and was transported by ambulance to a local hospital for treatment.

The on-site investigation consisted of the inspection of the Softstop end terminal and guardrail system, photographs and measurements of the damage it sustained during the crash, and an assessment of its performance. The physical environment of the roadway and the guardrail were measured electronically by total station. The exterior and interior of the Pontiac were inspected, including measurement of the structural deformation and intrusion, identification of occupant contact points, and an assessment of manual restraint use and supplemental restraint deployment/actuation. The Pontiac was equipped with an event data recorder (EDR) that was imaged during the SCI inspection using the Bosch Crash Data Retrieval (CDR) scan tool.

CRASH SUMMARY

Crash Site

This single-vehicle crash occurred during daytime of May 2017. At the time of the crash, the National Weather Service reported a temperature at 27.8 ºC (82 ºF) and a relative humidity of 54 percent, with clear skies and south-southwest winds at 37.0 km/h (23.0 mph). The police-reported environmental conditions were clear and dry. The roadway consisted of a one-way, single-lane exit ramp oriented for south traffic flow. The ramp was curved to the right with a measured radius of 220 m (722 ft). The super elevation of the curve measured 7.3 percent in the area of the crash. A yellow warning sign with an advisory speed of 72 km/h (45 mph) was posted at the beginning of the ramp. The width of the single traffic lane measured 4.5 m (14.8 ft). The travel lane was bordered by a 1.0 m (3 ft) wide left shoulder and a 0.7 m (2.2 ft) wide right shoulder. Guardrails were positioned immediately beyond the shoulders. The left guardrail began approximately 91 m (300 ft) south of the gore area formed at the initiation of the exit ramp (**Figures 2 and 3**). A tire mark attributed to the left front tire of the Pontiac was observed along the left roadside (represented by the blue cones in **Figure 3**). The tire mark began at the edge of the pavement 12.2 m (40.0 ft) north of the guardrail impact and ended at Post 0 of the installation (the point of impact). The mark had a shallow clockwise arc.

The guardrail bordering the right roadside was also contacted during the crash sequence. A 2.9 m (9.5 ft) section of the W beam was deformed from secondary contact with the Pontiac. This deformed section was located 9.2 m (30.2 ft) south of the initial point of impact (Post 0). A Crash Diagram is included at the end of this technical report on Page 12.

Figure 2: South-looking trajectory view of the Pontiac at the beginning of the ramp approximately 91 m (300 ft) from the guardrail impact.

Figure 3: South-looking trajectory view of the Pontiac approximately 15 m (50 ft) from the guardrail impact.

Pre-Crash

The Pontiac was driven by a belted 71-year-old female and was traveling southbound on the exit ramp. The EDR-reported speed of the vehicle was 113 km/h (70 mph) 5 seconds prior to algorithm enable (AE). A speed/time/distance analysis determined that the Pontiac was

approaching the exit approximately 137 m (450 ft) from the guardrail impact at this time. For undetermined reasons as the Pontiac traveled along the curvature of the ramp, the vehicle drifted to the left and the left tires departed the road edge 12.2 m (40.0 ft) north of the beginning of the guardrail. The leftward arcing characteristic of the mark indicated that the driver steered back to the right after the road departure and was attempting to correct the errant trajectory of the vehicle at the time of the impact. The estimated speed of the Pontiac 1 second prior to AE was 92 km/h (57 mph). It should be noted that 1 second prior to AE the EDR-reported speed of the Pontiac was 64 km/h (40 mph). This reported speed was inconsistent with the balance of the recorder pre-crash data and was considered under-reported. It was theorized that this speed was under-reported due to probable action of the vehicle's antilock brake system and an unrecorded brake application due to the asynchronistic of the recording. Refer to the Event Data Recorder section of this report for further detail.

Crash

The left corner aspect of the Pontiac's front plane struck the SoftStop end terminal of the guardrail installation (**Figure 4**). The force of the impact caused the deployment of the Pontiac's frontal air bags. The impact-momentum of the vehicle displaced the end terminal 4.9 m (16.0 ft) along the W-beam. The displacement of the end terminal crushed the rail and forced the deformed beam to the ground absorbing energy in the process. The left bias of the impact caused the Pontiac to initiate a counterclockwise rotation as the terminal was displaced.

Figure 4: South-looking image of the guardrail impact (Event 1).

Figure 5: Southwest-looking trajectory view toward Event 2 impact with the face of the guardrail on the opposite roadside.

The Pontiac rotated approximately 45 degrees and separated from the end terminal along a westerly trajectory. The Pontiac continued to rotate clockwise as it traveled 8.4 m (27.6 ft) across the exit ramp (**Figure 5**). As the vehicle reached approximately 230 degrees of rotation relative to its original heading, the left plane/front corner area of the vehicle struck the face of the W-beam on the west side of the road. This impact deformed the guardrail approximately 15 cm (6 in) laterally over a 3.0 m (9.8 ft) distance (**Figure 6**). The force of the impact stopped the

vehicle's rotation and the Pontiac rebounded along a south trajectory coming to final rest. At rest, the Pontiac was facing north denoted by a fluid spill 4.3 m (14.1 ft) from the west guardrail impact (**Figure 7**). This rest location was 17.1 m (56.1 ft) from the initial impact with the end terminal.

Figure 6: Southwest-looking image depicting the guardrail impact of the opposite road side.

Figure 7: North facing view of the Pontiac's final rest position and a lookback of its approach to the crash.

Post-Crash

The police and emergency medical service (EMS) personnel responded to the crash. The driver exited the vehicle under her own power. She stated to the police investigator that "I must have blacked out." She was transported by ambulance to the emergency room of a hospital that was located 18 km (11 miles) from the crash site. The Pontiac was removed from the crash site by a local tow agency where it was located at the time of the SCI inspection.

SOFTSTOP END TERMINAL AND GUARDRAIL

The SoftStop end terminal was an energy-absorbing end terminal used to terminate a 79 cm (31 in) high W-beam guardrail (**Figure 8**). The SoftStop installation consisted of a SoftStop rail flattening head, SoftStop anchor W-beam guardrail, anchor post (Post 0), two steel yielding terminal posts (SYTP) at post locations 1 and 2, and six standard posts at post locations 3 to 8 that supported the W-beam with a composite block-out and carriage bolt. The SoftStop was manufactured by Trinity Highway Products, and the end terminal was a MASH TL-3 system.

Figure 8: Image depicting an exemplar SoftStop end terminal and guardrail. Image obtained from the manufacturer's website.

Manufacturer literature and installation manuals for the SoftStop system can be found at: www.highwayguardrail.com/products/SoftStop.html. The deformed guardrail was inspected and documented through measurements and photographs. A diagram depicting the deformed guardrail is included on Page 13. The completed FHWA guardrail form is included at the end of this report as **Appendix A**.

The struck guardrail (**Figure 9**) was a tangent system with a measured W-beam height of 79 cm (31.0 in). This height was measured at an undamaged section at Post 6. The Pontiac struck the impact face of the end terminal (originally located at Post 1) and displaced it along the W-beam. The impact face measured 18 x 51 cm (7 x 20 in), width x height. Due to its design, the terminal crushed and flattened the W-beam during its movement, thus absorbing energy of the impact. The posts numbered 0 to 4 of the installation were damaged. The total length of damaged W-beam measured 8.8 m (29 ft). This length included the 4.9 m (16 ft) of extrusion plus a 3.9 m (13 ft) of rail section that included a small wrinkle in the top W-beam flange near Post 5. Due to the splice locations, this wrinkled section of rail required replacement to the splice located between Posts 8 and 9.

Figure 9: South-looking oblique view of the deformed guardrail system at the SCI inspection.

Figure 10: West-looking image of the guardrail at its initial inspection by the MoDOT inspector. Image supplied by MoDOT.

Post 0 was a 16 x 16 cm (6.25 x 6.25 in) I-beam that was embedded into the ground and anchored the W-beam through a turnbuckle attachment. During the crash, the turnbuckle remained attached to the anchor post and provided tension to the deforming rail. However, at some point during the crash sequence, the turnbuckle separated from the post. At initial inspection the MoDOT inspector found the turnbuckle and crushed W-beam separated from Post 0 lying on the shoulder (**Figure 10**). The inspector moved the crushed W-beam to the field side, so it did not present a hazard in the roadway.

A ground angle strut located between Post 0 and Post 1 also tensioned the system. The ground strut remained intact during the crash. Post 1 was a yielding 15 x 10 cm (6 x 4 in) I-beam that supported the end terminal pre-crash. This post was weakened by holes drilled through the end plates of the I-beam. The manufacturer's instructions indicated that the weakening holes were to be installed at ground level. At inspection these holes were approximately 3 cm (1 in) above ground level. During the impact, this post fractured through the weakening holes and deformed approximately 80 degrees along the direction of the Pontiac's travel.

Post 2 was also a yielding 15 x 10 cm (6 x 4 in) I-beam. Its holes were located approximately at ground level. This post deformed approximately 10 degrees by bending at the holes and rotated counterclockwise. This post had a composite block-out and as the installation directions indicated the W-beam was not attached to the post.

All posts beyond Post 3 were standard 15 x 10 cm (6 x 4 in) I-beams that supported the W-beam with a composite block-out and carriage bolt. During the crash, the bolt head at Post 3 pulled through the W-beam by deforming the hanger slot in the rail. The composite block-out at Post 3 fractured. Post 3 deformed by bending approximately 30 degrees. The carriage bolt at Post 4 partially disengaged as the movement of the end terminal was captured. Post 4 was slightly deformed with 5 to 10 degrees of counterclockwise rotation. There was no damage to the system at Post 5 or beyond.

The end terminal (**Figures 11 and 12**) was displaced 9.8 m (16 ft) by the Pontiac. The downstream end of the terminal was captured at the carriage bolt of Post 4. Inspection of the end terminal was unremarkable. No welds were broken and it was relatively undeformed.

Figure 11: Northwest-looking oblique view of the displaced end terminal.

Figure 12: Overhead view of the downstream aspect of the end terminal depicting its capture on the Post 4 carriage bolt.

2004 PONTIAC SUNFIRE

Description

The 2004 Pontiac Sunfire, two-door coupe (**Figure 13**), was identified by Vehicle Identification Number 1G2JB12F847xxxxxx. Its date of manufacture was unknown. The Pontiac was equipped with the base-level trim package. The vehicle was configured on a 264 cm (104.0 in) wheelbase with an overall length of 470 cm (185.2 in). The powertrain consisted of a 2.2-liter, transverse-mounted, 4-cylinder, gasoline engine linked to a 3-speed automatic transmission. Standard equipment included power-assisted front disc/rear drum brakes with ABS, traction control, and power-steering. The gross vehicle weight rating for this vehicle was 1,664 kg (3,669 lb) with gross axle weight ratings of 907 kg (2,000 lb) front and 757 kg (1,669 lb) rear. At the time of the crash, the Pontiac was configured with Headway tires at the left front, left rear, and right front axle. The tire at the right rear axle location was a Goodyear Viva 2. All tires were the manufacturer-recommended size of P195/65R15. The specific tire data at the time of the SCI inspection was as follows:

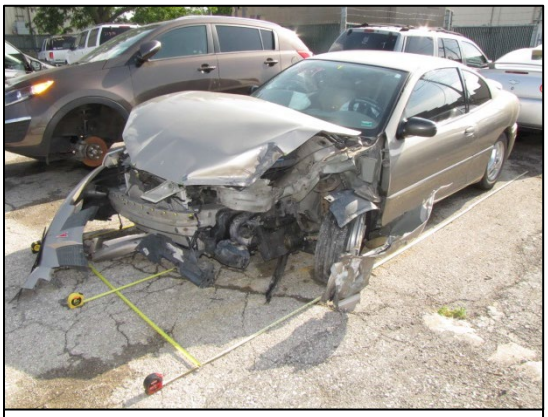


Figure 13: Front left oblique view of the Pontiac depicting its deformation.

Position	Identification Number	Measured Tread Depth	Restriction	Damage
LF	TWB8 HCH XXXX	3 mm (4/32 in)	Yes	Cut and debeaded, rim fractured in two places
LR	TWB8 HCH XXXX	6 mm (8/32 in)	No	None
RR	MDV9 JA2R 2913	6 mm (7/32 in)	No	None
RF	TWB8 HCH XXXX	4 mm (5/32 in)	No	None

The interior of the Pontiac was configured for seating of 5 occupants with front row (forward folding) bucket seats and a 3-passenger rear bench seat. The driver seat was adjusted in a mid-track position. The front row right seat was adjusted fully forward. The head restraints in the front row were adjustable (both fully down). Manual restraint was provided by 3-point lap and shoulder seat belts for the 5 seat positions. The front seat belts were equipped with an energy management loop (EML) at the floor anchor. Supplemental restraint consisted of dual- stage front air bags for the driver and front row right positions. The Pontiac was not equipped with side impact air bags or inflatable curtain (IC) air bags due to its age.

Exterior Damage

The exterior damage of the Pontiac (**Figure 14**) was present on the left aspect of the front plane and the forward aspect of the left plane. Due to the vehicle dynamics and the physical locations of the crash events, the two damage patterns overlapped each another. The exact locations of the

direct contact damage and crush attributable to each crash event was masked due to the overlap. The resultant frontal crush was a composite profile attributable to both impacts. For reference purposes only, the profile (after adjustment for freespace) was as follows: C1 = 3 cm (1.2 in), C2 = 3 cm (1.2 in), C3 = 2 cm (0.8 in), C4 = 1 cm (0.4 in), C5 = 1 cm (0.4 in), C6=0. The crush profile could not be used for analysis due to the overlapping properties.

Figure 14: Overhead view of the Pontiac depicting its deformation.

The SCI reconstruction crash determined that there was a general alignment of the vehicle's left tire track with the end terminal. This orientation of the approaching vehicle positioned the direct contact with the end terminal at the left corner of the front plane, immediately beyond the left end of the bumper reinforcement bar. The force of this impact was absorbed by the (relatively) softer structures underlying the left fender area and then the left front wheel assembly. Using exemplar measurements of an undamaged Pontiac Sunfire, the Event 1 direct contact damage began approximately 56 cm (22.0 in) left of center and extended 18 cm (7.0 in) to the left corner. The depth of crush extended approximately 76 cm (30.0 in) rearward along the left plane. The left front wheel assembly was directly involved in the contact. This front wheel rim was compressed and fractured and the left wheelbase was shortened 23 cm (9.0 in). The collision deformation classification (CDC) assigned to this damage pattern was 12FLEE3. Analysis of this impact was beyond the scope of the WinSMASH program due to the corner impact configuration and the yielding properties of the end terminal.

The Pontiac separated from the Event 1 impact with a counterclockwise rotation and rotated approximately 230 degrees as it crossed the roadway impacting the face of the guardrail on the opposite roadside. The vehicle struck this guardrail with the front aspect of its left plane. Due to the previous impact, the damaged structure of the left fender area was exposed to the guardrail face. There was direct contact damage at the left front wheel extending forward to the front left corner area overlapping the Event 1 damage. The direction of force was in the 10 o'clock sector evidenced by the lateral deformation and deflection of the front bumper reinforcement. The right lateral deformation of the entire bumper reinforcement structure measured 15 cm (6.0 in). The estimated CDC assigned to the damage pattern was 10LFEW2. Lateral crush measurements were not taken due to the overlap of the damage patterns.

Event Data Recorder

The Pontiac Sunfire was equipped with an air bag control module that performed the diagnostic, sensing and deployment command functions for the vehicle's supplemental restraint systems. This module had EDR capabilities and was fastened to the floor pan under the front row right

seat. The EDR component was imaged with the Bosch Crash Data Retrieval tool and software version 17.3 via a connection to the Diagnostic Link Connector and external 12-volt power supplied through the fuse-block. The imaged data is reported with version 17.9.1 and is included at the end of this report as **Appendix B**.

The data limitations reported that this EDR was capable of recording two event types, namely Non-Deployment events and Deployment events and had the capacity to store a total of two events. It could store one Non-Deployment event. The Non-Deployment event could be overwritten if it was not locked. A Non-Deployment event was considered to be locked if it occurred within a 5-second window of a Deployment event. Deployment events were considered to be locked events and could not be overwritten. The EDR could store up to two Deployment events. A 5-second pre-crash buffer that described various vehicle performance parameters (including vehicle speed, throttle percentage, brake switch status, and engine RPM) was recorded for each event record. These performance parameters were recorded asynchronously in one-second intervals.

The imaged data report indicated that the EDR had recorded one Deployment and one Non-Deployment event. Both events occurred on ignition cycle 21,861. The data was imaged on ignition cycle 21,864. The driver seat belt was buckled. The System Status tables of the events indicated that the Deployment event occurred first followed by the Non-Deployment event 1.3 seconds later. The recorded data was consistent with the crash under investigation.

Deployment Event

This recorded event was consistent with the end-terminal impact (SCI Event 1). The maximum recorded delta V was -14.29 km/h (-8.88 mph) at 122.5 milliseconds. However, this value under-reported the total crash severity of the impact. Referencing the crash pulse graph, the entire crash event was not recorded as it was determined that the acceleration of the impact was still active at the end of the recording. The delta V data had not reached a plateau.

The trends of the pre-crash data reported that the speed of the Pontiac was 113 km/h (70 mph) 5 seconds prior to AE and through a combination of rolling resistance and braking slowed to 92 km/h (57 mph) 2 seconds prior to AE. The EDR-reported speed of the Pontiac 1 second prior to AE was 64 km/h (40 mph); however, this value was not consistent with the surrounding data and the pre-crash data of the (subsequent) Non-Deployment event. The under-reported speed was likely due to the action of the ABS system and an unrecorded brake application due to the asynchronous nature of the data recording. The speed of the Pontiac 1 second prior to AE was estimated to be a 92 km/h (57 mph).

Non-Deployment Event

This recording was attributed to the secondary impact with the face of the guardrail (SCI Event 2). The maximum recorded delta V -13.39 km/h (-8.32 mph) at 107.5 milliseconds. A review of

this crash pulse indicated the impact was completely recorded (the delta V had reached at plateau).

Interior Damage

The interior damage to the Pontiac (**Figure 15**) consisted of the deployment of the frontal air bags. There was no intrusion of the interior components or identified occupant contacts to the interior. The right aspect of the windshield was fractured by the contact from the cover flap of the passenger's frontal air bag module during its deployment.

Figure 15: Left interior view of the Pontiac.

The steering wheel/column was not adjustable. There was no deformation of the steering wheel rim. The mid-track position of the driver seat measured 10 cm (4.1 in) rear of full forward. The seat track travel measured 20 cm (8.0 in). The seat back was reclined 15 degrees. The horizontal distance from the seat back to the center hub of the steering wheel rim measured 59 cm (23.3 in).

Manual Restraint Systems

The Pontiac was equipped with manual 3-point lap and shoulder seat belts for the five designated seating positions. Each seat belt consisted of continuous loop webbing, a sliding latch plate, and a fixed D-ring. The driver's seat belt used an Emergency Locking Retractor (ELR).

The driver was restrained by the seat belt based on the observations during the SCI vehicle inspection. The seat belt webbing was stowed in the retractor at initial inspection. Its extraction and examination revealed that the webbing was roped and jammed at the latch plate indicative of occupant loading. The (jammed) latch plate was located 79 cm (31.0 in) above the floor anchor. The lap portion of the ebbing was waffled and loaded over a 25 cm (10.0 in) section from 53 cm to 79 cm (21.0 in to 31.0 in) above the anchor. A 20 cm (8.0 in) crease was observed in the shoulder portion of the webbing. The crease began 53 cm (21 in) above the latch plate and ended at the D-ring. The energy management loop (EML) at the floor anchor was intact.

Supplemental Restraint Systems

The Pontiac was equipped with dual-stage frontal air bags for the driver and front row right occupant. During the guardrail end terminal impact, the both air bags deployed from their module locations. Examination of the air bags was unremarkable. There was no evidence of occupant contact to the driver air bag.

2004 PONTIAC SUNFIRE OCCUPANT

Driver Demographics

Age/Sex:	71 years/female
Height:	155 cm (61.0 in)
Weight:	132 kg (291 lb)
Eyewear:	Unknown
Seat Type:	Forward-folding bucket seat with adjustable head restraint
Seat Track Position:	Mid-track
Manual Restraint Usage:	3-point lap and shoulder seat belt
Usage Source:	Vehicle inspection
Air Bags:	Front air bag available and deployed
Alcohol/Drug Involvement:	None
Egress From Vehicle:	Exited under her own power
Transport From Scene:	Ambulance to a hospital
Type of Medical Treatment:	Treated and released

Driver Injuries

Injury No.	Injury	AIS 2015	Involved Physical Component	IPC Confidence Level
1	Left lower leg contusion	810402.1	Left lower instrument panel	Certain

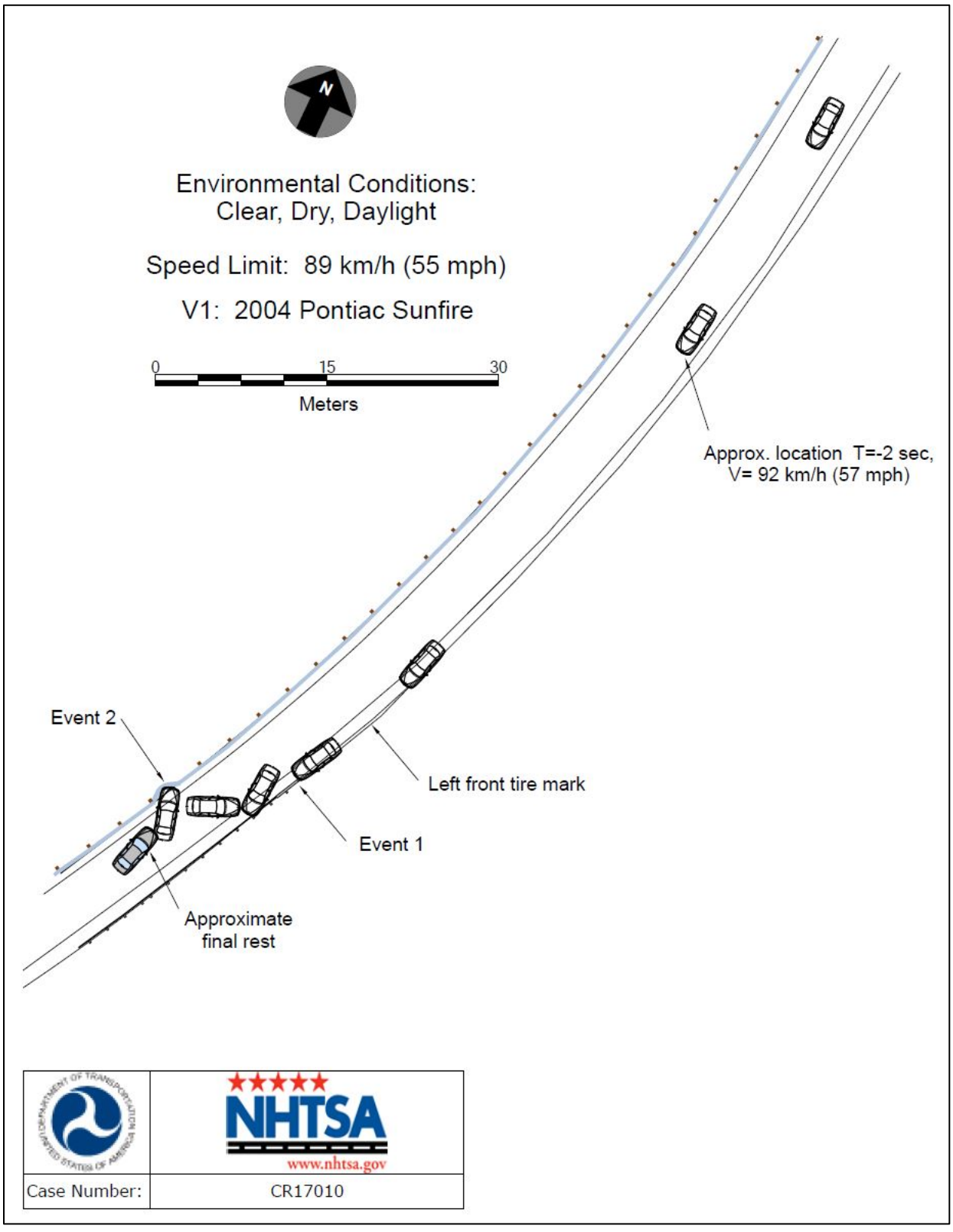
Source: Hospital records

Driver Kinematics

The 71-year-old female driver was operating the vehicle with the driver seat adjusted in a mid-track position. She was restrained by the vehicle's 3-point lap and shoulder seat belt. The Pontiac departed the left road edge as it traversed the right curve of the exit ramp. As the driver steered to correct the errant trajectory, the front plane/left aspect of the vehicle struck the end terminal.

At impact the seat belt retractor locked and the driver's frontal air bag deployed. The driver initiated a forward trajectory in response to the 12 o'clock direction of the impact force. She loaded the seat belt and deployed air bag with her torso and rode down the force of the multiple event crash. The driver's lower extremities contacted the left lower instrument panel resulting in a soft tissue injury to the left lower leg. She then rebounded back into her seat and came to rest. She was able to exit the vehicle under her own power and was subsequently transported by ambulance to a hospital with police-reported non-incapacitating injuries.

CRASH DIAGRAM



APPENDIX A:

Federal Highway Administration Guardrail Forms

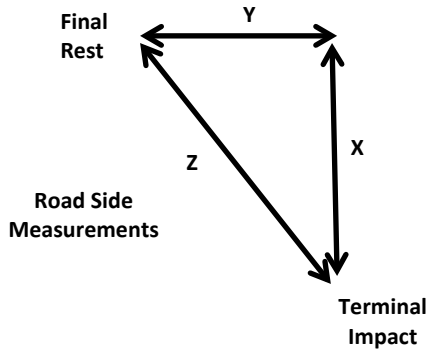
Case No.: CR17010

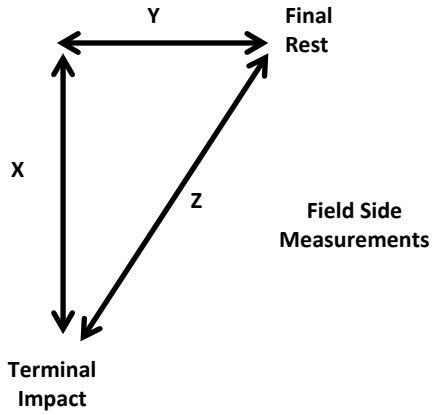
PREPOPULATED DATA (BY OTHERS)			
Date of Crash	May 2017	**Time of Crash (Military)**	Daytime
Case Number	CR17010	**State**	MO
Traffic Route	Limited Access Ramp	**Direction (Southbound = SB)**	SB
Ambient Conditions (at time of crash)			
Temperature (°F)	82°	**Lighting**	Day
Atmospheric	Clear		

SCENE INFORMATION	
Type of area where crash occurred	❒ Urban ❒ Rural ☒ Suburban
Terminal on a horizontal curve?	❒ No ❒ Curve/LT ☒ Curve/RT
Estimated or Reconstructed Speed at Impact (mph)	Estimated 55 mph, EDR-reported 57 mph
Est. distance (straight line) from terminal impact to COM final rest position (ft.)	Z = 96.5 ft ☒ Road side ❒ Field Side
Est. distance (longitudinal) along guardrail from terminal impact to COM final resting location (ft.)	X = 95.1 ft
Est. distance (normal) from either 1. the white paint line; or 2. roadway/shoulder/pavement edge to COM rest position (ft.)	Y = 10.5 ft
Super elevation	☒ +2% ❒ -2% ❒ NONE or FLAT
Curve Radius (ft.)	722 ft

KEY:

- COM - Center of Mass of Vehicle
- Distance Measurements





Case No.: CR17010

ON-SCENE INFORMATION		
End Treatment Type	☒ Extruder	❒ ET2000 ❒ ET-PLUS 4in ❒ ET-PLUS 5in ❒ SKT ❒ FLEAT ☒ SOFT STOP
	❒ Telescope	❒ X-LITE ❒ X-TENSION
Curb?	☒ No ❒ Yes	❒ AASHTO Type A ❒ AASHTO Type B ❒ AASHTO Type C ❒ AASHTO Type D ❒ AASHTO Type E ❒ AASHTO Type F ❒ AASHTO Type G ❒ AASHTO Type H
Curb Height: N/A		

GUARDRAIL INSTALLATION									
Post No.	Post		Block-Out		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post (ft. -in.)
	Type	Dim.	Type	Dim.	Yes No Unknown	Describe	Travel way	Curb	
	Steel Wood Other	D x W (in.) or Dia. (in.)	Steel Wood Composite	D x W (in.)					
0	Steel	7.1 x 6.5	None	N/A	No		3.5	N/A	
1	Steel	4 x 6	None	N/A	No	N/A	3.5	N/A	4’-6”
2	Steel	4 x 6	Composite	4 x 7.5 x 14	No	N/A	4.25	N/A	5’-6”
Post No.	Post		Offset Block		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post

Case No.: CR17010

GUARDRAIL INSTALLATION									
Post No.	Post		Block-Out		PRE-Existing Damage		Offset to post or post hole (ft.)		Spacing to next post (ft. -in.)
	Type	Dim.	Type	Dim.	Yes No Unknown	Describe	Travel way	Curb	
	Steel Wood Other	D x W (in.) or Dia. (in.)	Steel Wood Composite	D x W (in.)					
	Type	Dim.	Type	Dim.	Yes No Unknown	Describe	Travel way	Curb	(ft. -in.)
	Steel Wood Other	D x W (in.) or Dia. (in.)	Steel Wood Composite	D x W (in.)					
3	Steel	4 x 6	Composite	4 x 7.5 x 14	No	N/A	4.25	N/A	6’-4”
4	Steel	4 x 6	Composite	4 x 7.5 x 14	No	N/A	4.25	N/A	6’-2”
5	Steel	4 x 6	Composite	4 x 7.5 x 14	No	End of Impact Damage	4.25	N/A	6’-1”
6									
7									

Additional Comments:

W-beam also replaced to splice between Post 8 and 9 due to wrinkle in beam near splice at Post 5

NONE

Case No.: CR17010

EXTRUDER			
Feeder Channel Width at impact head	❒ 4inches ❒ 5 inches ☒ Other 5.25" Soft Stop		
Guide Chute Exit Height (in.)	5.25 inches		
Connection of feeder channels to head damaged?	☒ No Yes	Are Welds Broken?	☒ No ❒ Yes
Anchor Cable Present?	❒ No ❒ Yes	Pre-crash Connected?	❒ No ❒ Yes
Rail Extrusion?	❒ No ☒ Yes	Length (ft. in.)	16 ft
Rail Extrusion Direction	❒ Traffic Side ❒ Field Side ☒ N/A		
Total Length of Rail Damaged (ft.) [total length would include extruded rail plus damaged rail downstream from head.]	29 ft: 16 ft of extrusion plus replacement of 13 ft section due to a wrinkle in beam.		

TELESCOPE				
Rail Displacement	❒ No	❒ Yes; Length:	No of Panels Displaced	❒ 1 ❒ 2 ❒ 3 ❒ 4 ❒ 5 ❒ 6

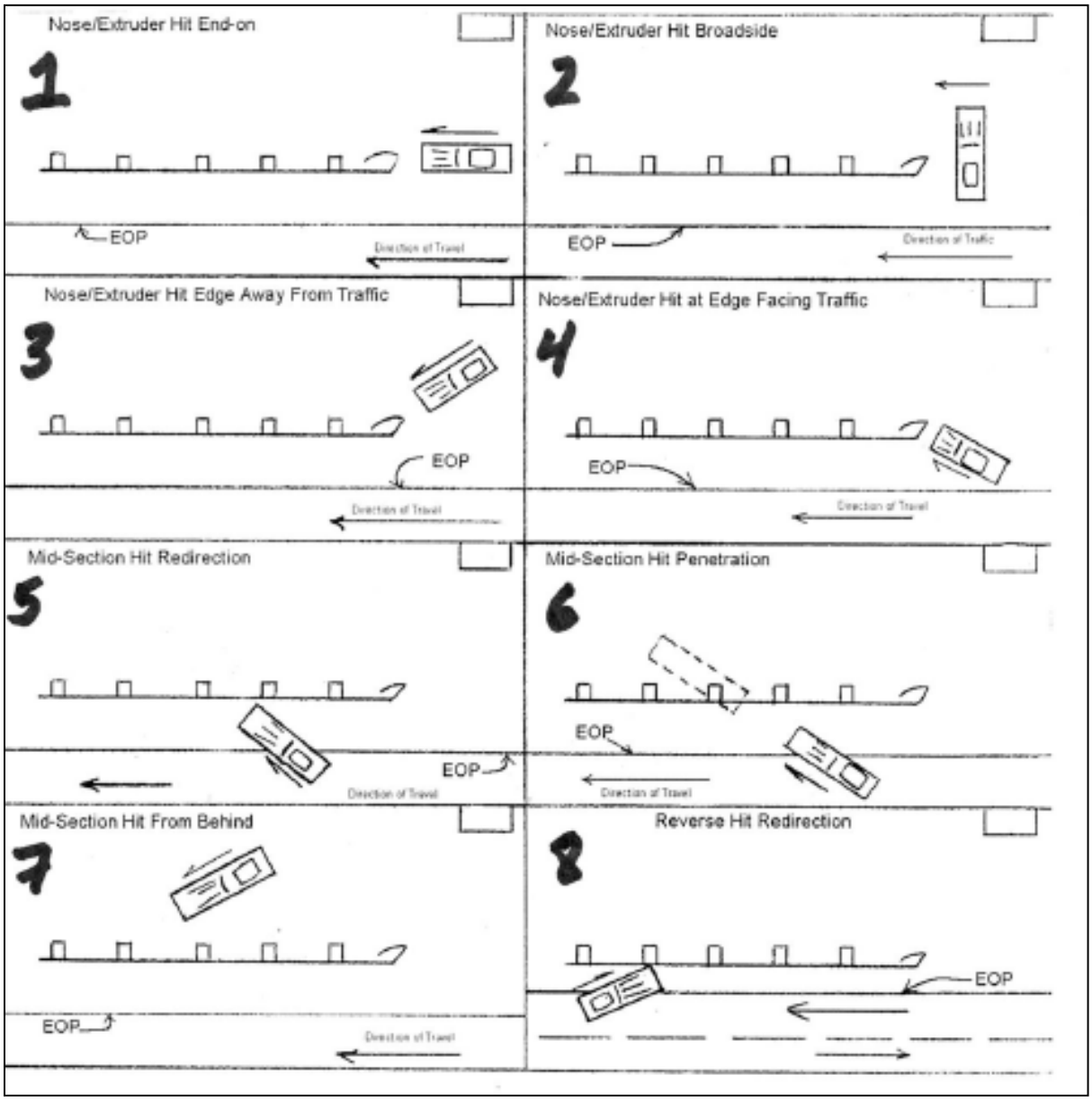
ALL-SYSTEM PERFORMANCE			
Railkinks Downstream of Head?	☒ No	❒ Yes;	No. of Kinks:
Was there intrusion into the Occupant Compartment by foreign object (guardrail)?	☒ No ❒ Yes		
Did vehicle impact other objects after impact with terminal?	❒ No ☒ Yes		
Object Contacted	Guardrail face on opposite roadside		

ALL-SYSTEM PERFORMANCE ENVIRONMENT			
SIDESLOPE	**50 ft in advance of Post 1**	**At Post 1**	**50 ft Past Post 1**
Percent - %	Level	Level	Level
Adjacent Lane Width (ft)	15.3ft		
Lane Type (NAS EDS Variable: Sur. Type)	Asphalt		
Shoulder Type	Asphalt		
Shoulder Width (ft)	3.0 ft		
Guardrail Height (in)	31 in in undamaged section at Post 6		

Case No.: CR17010

VEHICLE INFORMATION		
Vehicle Type (NHTSA Input)	2004 Pontiac Sunfire	
Vehicle Identification Number (VIN)	1G2JB12F847xxxxxx	
Vehicle Mass (NASS var.: veh.wgt)	3,669 lb Gross Weight Rating	
Vehicle orientation upon impact	☒ Case Type 1 ❐ Case Type 2 ❐ Case Type 3 ❐ Case Type 4 ❐ Case Type 5 ❐ Case Type 6 ❐ Case Type 7 ❐ Case Type 8 ❐ Other	
If 'Other', describe	N/A	
Collision Deformation Classification	12FLEE3, 10LFE999	
Delta-V	Unknown	
Occupant Compartment Penetration of rail	☒ No	❐ Yes; Describe:
Did the Vehicle Rollover?	❐ Yes ☒ No	
Quarter Turns (NASS EDS variable: Rollover)	❐ 1 ❐ 2 ❐ 3 ❐ 4 ❐ 5 ❐ 6 ❐ 7 ❐ 8 ❐ 9 ❐ 10 ❐ 11 ❐ 12 ❐ 13 ❐ 14 ❐ 15 ❐ 16 ❐ 17+	
Object Precipitating Rollover, (NASS EDS variable: Rollobj)	N/A	
Rollover Type, Terhune Scale, (NASS EDS variable: rolintyp)	N/A	

Case No.: CR17010



APPENDIX B:

2004 Pontiac Sunfire Event Data Recorder Report

The EDR Report contained in this technical report was imaged using the current version of the Bosch CDR software at the time of the vehicle inspection. The CDR report contained in the associated Crash Viewer application may differ relative to this report.

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	1G2JB12F847******
User Case Number	
EDR Data Imaging Date Crash Date	05/18/2017
Filename Saved on	CR17010_V1_ACM.CDRX Thursday, May 18 2017 at 19:48:37
Imaged with CDR version Imaged with Software Licensed to (Company Name) Reported with CDR version	Crash Data Retrieval Tool 17.3 NHTSA Crash Data Retrieval Tool 17.9.1
Reported with Software Licensed to (Company Name)	NHTSA
EDR Device Type Event(s) recovered	Airbag Control Module 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 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.

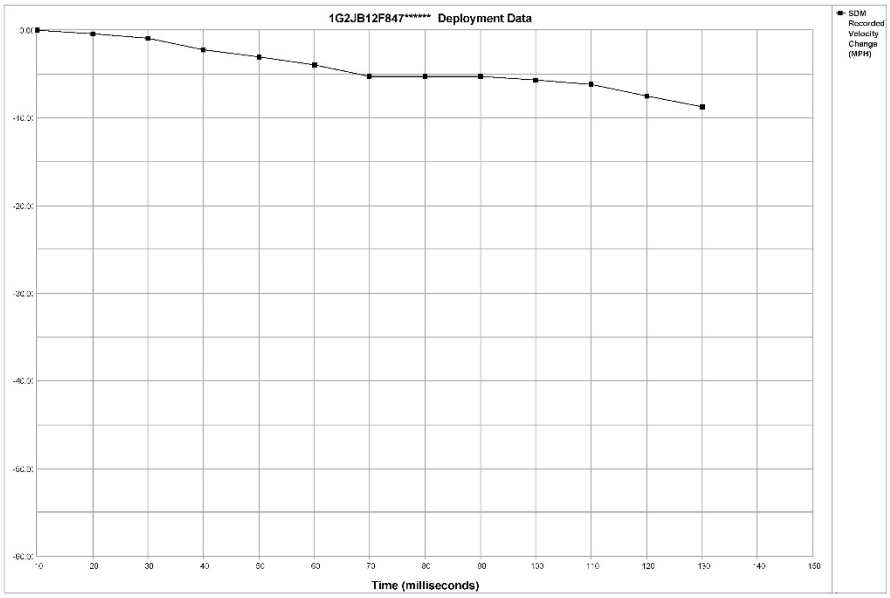
01025_SDMG-99JXZ09-10_r004

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger SIR Suppression Switch Circuit Status (if equipped)	Air Bag Not Suppressed
Ignition Cycles At Deployment	21861
Ignition Cycles At Investigation	21864
Maximum SDM Recorded Velocity Change (MPH)	-8.88
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	122.5
Time Between this Event and the Previous Event (sec)	N/A
Time From Algorithm Enable to Deployment Command Criteria Met (msec)	32.5

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	70	3712	0
-4	66	3520	0
-3	61	3200	0
-2	57	3008	0
-1	40	2368	29

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



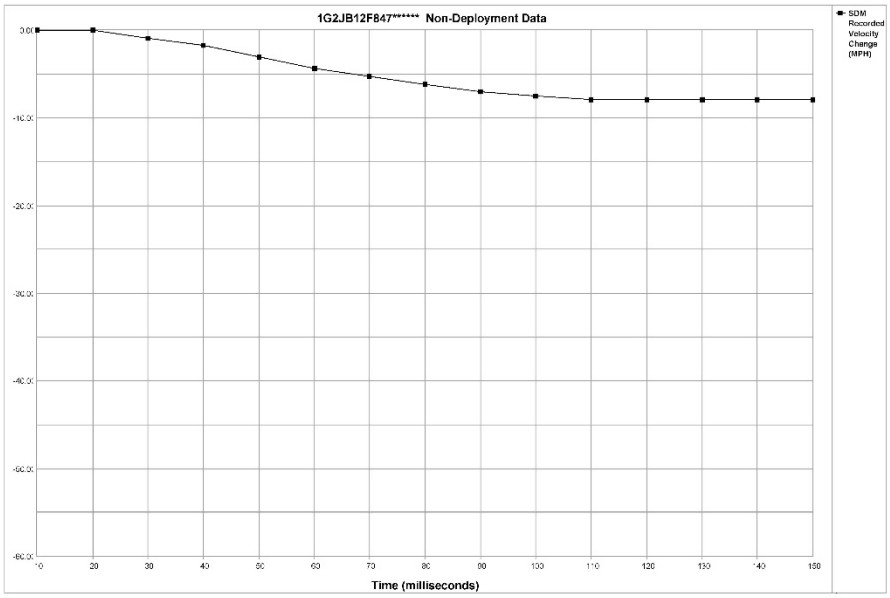
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	-0.44	-0.88	-2.19	-3.07	-3.95	-5.27	-5.27	-5.27	-5.70	-6.14	-7.46	-8.78	N/A	N/A

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger SIR Suppression Switch Circuit Status (if equipped)	Air Bag Not Suppressed
Ignition Cycles At Non-Deployment	21861
Ignition Cycles At Investigation	21864
Maximum SDM Recorded Velocity Change (MPH)	-8.32
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	107.5
Time Between this Event and the Previous Event (sec)	1.3

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	66	3520	0
-4	61	3200	0
-3	57	3008	0
-2	40	2368	29
-1	57	3072	0

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



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	0.00	-0.88	-1.76	-3.07	-4.39	-5.27	-6.14	-7.02	-7.46	-7.90	-7.90	-7.90	-7.90	-7.90

Hexadecimal Data

```
$01  08 23 00 00
$02  95 6B
$03  41 53 33 32 36 35
$04  4B 57 46 57 42 33
$05  00
$06  22 67 40 98
$10  F5 52 FF
$11  9A 03 9C 7D A2 00
$14  03 84 AB 80
$18  84 84 85 B8 FF 00
$1C  FA 32 4A FA FA FA
$1D  FA FA 32 4A FA FA
$1E  FA FA
$1F  FF 02 00 00 00
$20  A3 00 00 FF 80 FE
$21  DD BF FF FF FF FF
$22  FF FF FF FF FF FF
$23  7C 43 02 5F 01 00
$24  00 02 04 07 0A 0C
$25  0E 10 11 12 12 12
$26  12 12 00 5C 40 5C
$27  62 6B 00 18 00 00
$28  4B 00 00 00 00 30
$29  25 2F 32 37 00 F5
$2A  53 E0 FE 55 65 30
$2B  1E 30 27 00 00 00
$2C  00 25 10 00
$2D  2B 4D 26 00
$30  A0 00 00 FF 6A FF
$31  FF BF FF FF FF FF
$32  FF FF FF FF FF FF
$33  7C 10 03 01 00 01
$34  02 05 07 09 0C 0C
$35  0C 0D 0E 11 14 FF
$36  FF 0D 31 02 88 40
$37  5C 62 6B 70 00 30
$38  00 4B 00 00 00 00
$39  00 25 2F 32 37 3A
$3A  00 F5 53 E0 00 00
$3B  00 04 00
$3C  0D 31 31 31
$40  FF FF FF FF FF FF
$41  FF FF FF FF FF FF
$42  FF FF FF FF FF FF
$43  FF
```

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October 2019

U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

14071-102819-v7