

On-Site Child Restraint System Investigation
Dynamic Science, Inc. (DSI), Case Number DS10016
1996 Saturn SL1
Nevada
June 2010

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

1. Report No. DS10016		2. Government Accession No.		3. Recipient Catalog No.	
4. Title and Subtitle On-Site Child Restraint System Investigation				5. Report Date February 14, 2011	
				6. Performing Organization Report No.	
7. Author(s) Dynamic Science, Inc.				8. Performing Organization Report No.	
9. Performing Organization name and Address Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805				10. Work Unit No. (TRAIS)	
				11. Contract or Grant no. DTNH22-07-00045	
12. Sponsoring Agency Name and Address U.S. Dept. of Transportation (NVS-411) National Highway Traffic Safety Administration 1200 New Jersey Ave, SE Washington, DC 20590				13. Type of report and period Covered [Report Month, Year]	
				14. Sponsoring Agency Code	
15. Supplemental Notes					
16. Abstract This on-site investigation focused on the Child Restraint Systems (CRS) used by two occupants in a 1996 Saturn SL1 that was involved in a crash with another vehicle. The Saturn's second row occupants were a 4-year-old male seated in a forward-facing belt positioning booster safety seat and a 12-week-old female seated in a rear-facing infant safety seat. During the crash, the 4-year-old male sustained non-incapacitating injuries and the 12-week-old female was not injured. The vehicle's driver and front right occupant died following the crash from serious injuries. The crash occurred on an undivided two-lane roadway in June 2010 in the state of Nevada. The Saturn was being driven westbound by an unrestrained 26-year-old male. The front right seat was occupied by a restrained 19-year-old female. The other vehicle was a 1979 Chevrolet Blazer that was being driven eastbound by a 24-year-old male. While traveling at a high rate of speed, the driver of the Saturn lost control of the vehicle and entered the eastbound lane. The Saturn initiated a counterclockwise yaw and the front end of the Chevrolet impacted the right side of the Saturn. Following the impact, the Saturn came to rest on the roadway and the Chevrolet departed the roadway and overturned in a ditch. The child occupants were transported to a local hospital, treated, and released. The vehicles were towed due to damage.					
17. Key Words Child restraint system, air bag, injury, fatality			18. Distribution Statement		
19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price		

Dynamic Science, Inc.
Crash Investigation
Case Number: DS10016
TABLE OF CONTENTS

Background.	1
Summary.	2
Crash Site.....	2
Pre-Crash.	2
Crash.	2
Post-Crash.	3
Vehicle Data - 1996 Saturn SL1.	4
Vehicle Damage - 1996 Saturn SL1.....	4
Exterior Damage.	4
Interior Damage.	5
Manual Restraints - 1996 Saturn SL1.	5
Supplemental Restraint System - 1996 Saturn SL1.....	7
Event Data Recorder - 1996 Saturn SL1.	7
Child Restraint Systems - 1996 Saturn SL1.....	8
Vehicle Data - 1979 Chevrolet Blazer	10
Occupant Demographics.	12
Occupant Kinematics.....	13
Occupant Injuries.....	15
Attachment 1. Scene Diagram.	18
Attachment 2. Bosch CDR Report.	19

Background

This on-site investigation focused on the Child Restraint Systems (CRS) used by two occupants in a 1996 Saturn SL1 (**Figure 1**) that was involved in a crash with another vehicle. The Saturn's second row occupants were a 4-year-old male seated in a forward-facing belt positioning booster safety seat (BSS) and a 12-week-old female seated in a rear-facing infant safety seat (ISS). During the crash, the 4-year-old male sustained non-incapacitating injuries and the 12-week-old female was not injured. The vehicle's driver and front right occupant died following the crash from their injuries.



Figure 1. Subject vehicle, 1996 Saturn SL1

The crash occurred on an undivided two-lane roadway in June 2010 in the state of Nevada. The Saturn was being driven westbound by an unrestrained 26-year-old male. The front right occupant was a restrained 19-year-old female. The other vehicle was a 1979 Chevrolet Blazer (**Figure 2**) that was being driven eastbound by a 24-year-old male. While traveling at a high rate of speed, the driver of the Saturn lost control of the vehicle and entered the eastbound lane. The Saturn initiated a counterclockwise yaw and the front end of the Chevrolet impacted the right side of the Saturn. Following the impact, the Saturn came to rest on the roadway and the Chevrolet departed the roadway and overturned in a ditch.



Figure 2. Other vehicle, 1979 Chevrolet Blazer

This investigation was initiated by a DSI investigator during a review of a news article reporting a crash in which two adult occupants died and two child occupants using CRS were injured. On August 4, 2010, DSI forwarded the news article to the National Highway Traffic Safety Administration (NHTSA) for review and DSI was instructed to commence the investigation. On August 5, 2010, DSI obtained a preliminary police report and permission to inspect the subject vehicle. The Saturn was located at a tow facility and the two CRS were still in the vehicle. The subject vehicle and CRS inspections were completed on August 10, 2010. The vehicle's Event Data Recorder (EDR) was supported by the Bosch Crash Data Retrieval system and the EDR was imaged during the vehicle inspection. The EDR data was summarized in this report and the Bosch report is included in this report in Attachment B.

The Chevrolet was located at an auto auction facility and permission was obtained from the insurance company to inspect the vehicle. An exterior inspection of the Chevrolet was completed on August 11, 2010.

Summary

Crash Site

The crash occurred on an undivided east/west asphalt roadway that had a posted speed limit of 72 km/h (45 mph). At the time of the crash, conditions were dusk without street lamp illumination, partly cloudy and dry. The temperature at the nearest reporting station was 34.0° C (93.2° F), winds were east/southeast at 5.6 km/h (3.5 mph) and visibility was 16.0 km (10.0 mi).



Figure 3. Crash site, looking west

The eastbound and westbound lanes were separated by double yellow solid painted stripes and the outboard roadway edges were marked by solid white painted fog lines (**Figure 3**). The travel lanes each measured 3.8 m (12.5 ft) in width and outboard of the travel lanes were gravel shoulders. Approaching the area of impact, the westbound lane was straight and had a downhill grade that reached a maximum slope of negative 3.4 percent at the point of impact. The alignment for the eastbound lane included a slight left curve that ended 25.0 m (82.0 ft) west of the area of impact and a straight section that continued to the area of impact. The eastbound roadway profile had an uphill grade that reached a maximum slope of positive 3.5 percent at the east end of the left curve and continued uphill to the point of impact. At the area of impact the south shoulder measured 2.8 m (9.2 ft) in width. The shoulder ended at a steep descending embankment and a ditch with a vertical drop measuring 1.2 m (4.0 ft) below the roadway. A crash scene schematic is included at the end of this report as Attachment A.

Pre-Crash

The Saturn was traveling westbound at a police-estimated speed of 89 km/h (55 mph) and had just passed a westbound vehicle in a no-passing zone. After reentering the westbound lane, the driver of the Saturn lost control of the vehicle and the tire yaw marks indicated the driver steered left in an attempt to regain control of the vehicle. The Saturn right front tire deposited a yaw mark measuring 44.0 m (144.4 ft) beginning in the westbound lane and ending at the point of impact (POI). The right rear tire deposited a yaw mark measuring 34.5 m (113.2 ft) in length beginning and ending in the westbound lane at 13.0 m (42.7 ft) from the POI. The left front tire deposited a yaw mark measuring 18.8 m (61.7 ft) beginning at the center line and ending at the POI. The Chevrolet was traveling eastbound at a police-estimated speed of 56 - 72 km/h (35 - 45 mph).

Crash

The crash sequence included two events. Initially, the front end of the Chevrolet impacted the right side of the Saturn in an angle impact configuration (Event 1). **Figure 4** shows the westbound travel path of the Saturn to the point of impact. The POI was determined based on scene evidence

including the Saturn's tire yaw marks, a scrape mark located 80.0 cm (31.5 in) north of the south roadway edge, and a fluid spill deposit. For Event 1 the directions of force were within the 2 o'clock sector for the Saturn and the 12 o'clock sector for the Chevrolet. Following the first impact, the Saturn continued its counterclockwise rotation and was displaced rearward. It deposited a scrape mark measuring 2.3 m (7.5 ft) in length across the center line on its path to final rest, which was identified by a fluid spill deposit. The vehicle came to rest facing north in the eastbound lane and its estimated post-impact travel distance to final rest was 4.0 m (13.0 ft).



Figure 4. View showing the Saturn's westbound approach to the point of impact in the eastbound travel lane

The Chevrolet initiated a post-impact counterclockwise rotation and was displaced to the right. It traveled southbound for approximately 13.0 m (43.0 ft), departed the roadway on the right edge, and initiated a left side leading one-quarter turn fall-over type rollover (Event 2). The Chevrolet came to rest on its left side and facing west. Based on the furrow marks deposited at its final rest location, the roll distance was estimated to be 3.0 m (10.0 ft).

For the Saturn, the standard algorithm of WinSMASH calculated a Total Delta-V of 75.0 km/h (46.6 mph); the longitudinal and lateral components were -37.5 km/h (-23.3 mph) and -65.0 km/h (-40.4 mph), respectively. The program calculated a Barrier Equivalent Speed (BES) of 62.3 km/h (38.7 mph). Based on the vehicle's crush profile, the WinSMASH results were reasonable. The Saturn's EDR-reported maximum longitudinal Delta-V was -30.7 km/h (-19.09 mph). The Total Delta-V was 61.4 km/h (38.2 mph) and the lateral component was -53.2 km/h (-33.1 mph).¹

For the Chevrolet, WinSMASH calculated a Total Delta-V of 53.0 km/h (32.9 mph); the longitudinal and lateral components were -52.2 km/h (-32.4 mph) and 9.2 km/h (5.7 mph), respectively. The program calculated a Barrier Equivalent Speed (BES) of 63.2 km/h (39.3 mph). Based on the vehicle's front end crush profile, the WinSMASH results were reasonable.

Post-Crash

Following the crash, the 26-year-old male driver of the Saturn was removed from his vehicle by on-scene responders and transported to a local hospital where he was pronounced deceased at 2107 hours, 1 hour and 13 minutes post-crash. On-scene responders cut the safety belt webbing restraining the 19-year-old female seated in the front right seat of the Saturn. She was removed from the vehicle and pronounced deceased at the scene at 2355 hours. The 4-year-old male seated in the second row left seat was assisted from the vehicle by on-scene responders due to his age and transported to a local hospital where he was treated and released. The 12-week-old female seated

¹ Mathematically calculated based on the 60 degree Principal Direction Of Force

in the second row center position was removed from the vehicle by on-scene responders due to her age and transported to a local hospital where she was examined and released. Neither of the children received any follow-up medical treatment.

The driver of the Chevrolet was removed from the vehicle due to his injuries and was transported to a local hospital where he was admitted. Both vehicles were towed due to damage. The Saturn was sold to a private buyer on August 20, 2010. The Chevrolet was declared a total loss by the insurance company and sold to a private buyer on September 2, 2010.

Vehicle Data - 1996 Saturn SL1

The subject vehicle was a 1996 Saturn SL1 four-door sedan. Its date of manufacture was December 1995 and it was identified by the Vehicle Identification Number (VIN): 1G8ZH528XTZxxxxxx. The odometer reading obtained during the inspection was 204,414 km (127,017 mi). The vehicle was equipped with a 1.9-liter, 4-cylinder engine, automatic transmission, front-wheel drive, power assisted and ventilated front disc/rear drum brakes, power steering, and a tilt column.

The vehicle manufacturer recommended P175/70R14 tires for the front and rear and the recommended cold tire pressure was 207 kPa (30 psi) for the front and 179 kPa (26 psi) for the rear. The vehicle was equipped with Fisk Classic tires of the recommended size that were manufactured during August 2007 and mounted on original equipment manufacturer (OEM) steel rims. The specific tire data at the time of the vehicle inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	172 kPa (25 psi)	6 mm (8/32 in)	No	None
LR	110 kPa (16 psi)	7 mm (9/32 in)	No	None
RR	165 kPa (24 psi)	7 mm (9/32 in)	No	None
RF	Tire flat	6 mm (8/32 in)	Yes	Sidewall cut, holed and de-beaded

The Saturn's interior was equipped with fabric-covered five-passenger seating. The front row outboard bucket seats were separated by a center console and equipped with integral head restraints. The second row seat was a 60/40 split bench configured with folding backs and no head restraints.

Vehicle Damage - 1996 Saturn SL1

Exterior Damage

The Saturn sustained direct and induced damage to the right and top planes, and induced damage to the left, front and back planes. The right front tire sidewall was holed and de-beaded, and the rim sustained a 40-degree inboard cant. The right rear rim sustained a 5-degree outboard cant. The front and rear bumper fasciae and the right side view mirror were displaced. The right side polymer door

panels and front fender were displaced and the right rear polymer quarter-panel was fractured.

The direct damage to the right side began 95.0 cm (37.4 in) forward of the rear axle and extended forward 220.0 cm (86.6 in) to the front right bumper corner. The Field L extended from the rear bumper corner to the front bumper corner and measured 378.0 cm (148.8 in). Vertically, the direct damage to the right side extended from the sill to the roof and measured 109.0 cm (42.9 in). Six crush measurements were taken at mid-door level as follows (**Figure 5**): $C_1 = 8.0$ cm (3.1 in), $C_2 = 0$ cm, $C_3 = 7.0$ cm (2.8 in), $C_4 = 50.0$ cm (19.7 in), $C_5 = 54.0$ cm (21.3 in), $C_6 = 19.0$ cm (7.5 in). Maximum crush was located 199.0 cm (78.3 in) forward of the rear axle between C_4 and C_5 and measured 59.0 cm (23.2 in). The Collision Deformation Classification (CDC) for Event 1 was 02RYAW4.



Figure 5. Right side crush profile measurement of subject vehicle

The Saturn sustained direct damage to the left A-pillar, left B-pillar, and left side doors. The height of maximum door crush measured 74.0 cm (29.1 in), the sill height measured 32.0 cm (12.6 in), and the Door Sill Differential (DSD) was 18.0 cm (7.1 in).

Interior Damage

The Saturn sustained interior damage resulting from impact forces, intrusion, occupant loading, occupant contacts, and post-crash extrication activities. The windshield was fractured and out of place, and the left front, right front, right rear, and right rearmost side glass were disintegrated. The right front and rear side doors were jammed shut during the crash and the left front door was sprung open during extrication activities. The interior occupant compartment was reduced in size due to vertical, longitudinal, and lateral intrusions.

The Saturn's frontal air bags deployed during the crash and both air bags revealed evidence of occupant loading and damage from other sources. The front right safety belt webbing was cut during post-crash extrication activity. The front right seat back was deformed from intrusion of the right B-pillar. The front right door panel was fractured and the window crank was deformed from occupant contact. The left IP and steering column yielded scuff marks and the steering wheel rim sustained total collapse from occupant contact. The upper quadrant of the steering wheel rim was deformed 16.0 cm (6.3 in) forward and the lower quadrant was deformed 3.0 cm (1.2 in) forward. Additionally, the steering wheel rim's diameter was increased by 1.0 cm (0.4 in) laterally and decreased by 2.0 cm (0.8 in) vertically. The right and left front floor pans were buckled upward and the driver foot controls were deformed from intrusion and possibly by occupant contact. Also, the center console was fractured and displaced, exposing the center-mounted gear shift lever mechanism and the air bag control module (ACM).

Manual Restraints

The Saturn's front row seating was equipped with 3-point manual lap and shoulder safety belts with sewn-on latch plates and adjustable D-rings. The driver's safety belt was equipped with an Emergency Locking Retractor (ELR) and the front right passenger's safety had a switchable ELR/Automatic Locking Retractor (ALR). The driver's safety belt D-ring anchorage was in the full-up position, the latch plate was scratched indicating historical usage, and the safety belt webbing showed wear marks. The vehicle's EDR reported the driver's safety belt switch circuit status as unbuckled. The safety belt webbing and D-ring did not reveal evidence of occupant loading and the steering wheel was severely deformed due to occupant loading. Based on the vehicle inspection it was determined the driver was not restrained by the safety belt during the crash.



Figure 6. Front right occupant's safety belt as found during vehicle inspection



Figure 7. Left rear position safety belt latch plate showing occupant load marks

The front right passenger's safety belt D-ring was in the full-down position and the latch plate was scratched indicating historical usage. The lap and shoulder belt webbing were cut during extrication activities and at the time of the inspection the latch plate was found inserted into the buckle (**Figure 6**). The lap belt webbing was cut 43.0 cm (16.9 in) from the latch plate and the shoulder belt webbing was cut 41.0 cm (16.1 in) from the latch plate. The upper section of the shoulder belt was in the spooled out position and measured 41.0 cm (16.1 in) from the D-ring. The safety belt retractor was not functional due to B-pillar deformation. Based on the vehicle inspection, the front right safety belt was used to restrain the front right occupant during the crash.

The Saturn's second row manual restraints consisted of outboard lap and shoulder belts with continuous loop webbing and sliding latch plates, and a center position lap belt with a locking latch plate. The outboard belts were configured with switchable ELR/ALR retractors and non-adjustable D-rings.

The rear left lap and shoulder safety belt was used in combination with a Graco TurboBooster belt positioning BSS to restrain the 4-year-old male occupant. The latch plate revealed a scuff mark indicating occupant loading at impact (**Figure 7**).

The center position lap belt was used to install a Graco SnugRide rear-facing ISS used by the 12-

week-old female occupant. At the time of the inspection, the belt webbing was found routed through the ISS base (**Figure 8**). The latch plate was found unbuckled and a locking clip was attached to the webbing near the latch plate. The belt webbing measured 61.0 cm (24.0 in) from the seat cushion to the latch plate, which was the length required to properly install the ISS. The safety belt components were not damaged and did not show any evidence of occupant loading.

The Saturn was equipped with upper tether anchors for the second row seats and was not equipped with lower anchors.



Figure 8. Rear center seat position lap safety belt as found routed through ISS base

Supplemental Restraint System

The vehicle's Supplemental Restraint System (SRS) included an air bag control module (ACM) and driver and passenger frontal air bags. The driver of the Saturn was not the original owner of the vehicle and based on the interview it was not known if the air bags were original to the vehicle or if they had been recalled or serviced. The Saturn's first generation single-stage air bags were standard equipment for the model year. Both frontal air bags deployed at impact with the Chevrolet. Based on the EDR report, the time from Algorithm Enable (AE) to Deployment Command was 18.75 milliseconds (msec).

The left frontal air bag deployed from the steering wheel hub and measured 60.0 cm (23.6 in) in diameter. The air bag was configured with two vent ports on the back panel and two internal tethers attached to the center of the front panel. The air bag showed multiple occupant loading marks including a fabric transfer measuring 1.0 x 3.0 cm (0.4 x 1.2 in) located 18.0 cm (7.1 in) from the center in the upper left quadrant, a blood transfer located 5.0 cm (2.0 in) from the center, and a scuff mark measuring 2.0 x 3.0 cm (0.8 x 1.2 in) located 10.0 cm (3.9 in) from the center in the upper right quadrant. In the lower left quadrant a group of scuff marks was located 7.0 cm (2.8 in) from the center. On the right edge of the back panel abrasions and holes were located within an area measuring 15.0 x 7.0 cm (5.9 x 2.8 in) caused by occupant loading in combination with the right cover flap.

The right frontal air bag deployed from the top right IP. The air bag measured 72.0 cm (28.3 in) in width, 38.0 cm (15.0 in) in height, and 31.0 cm (12.2 in) in depth. The air bag revealed two holes in the upper left and right quadrants that were torn when contacted by the fractured windshield. A blood deposit and a fabric transfer measuring 10.0 cm in length located in the lower right corner of the air bag was deposited by the front right occupant when she loaded the air bag at impact.

Event Data Recorder

The EDR from the Saturn was imaged during the vehicle inspection by connecting the Bosch CDR Tool Version 3.3 directly to the ACM using a CDR cable. Vehicle damage prevented imaging via

the Diagnostic Link Connector (DLC) port. The crash data was reported using software Version 3.5.1. The recorded data included one non-deployment event and one deployment event. The non-deployment event occurred 170 ignition cycles prior to the deployment event and was not associated with the crash.

The deployment event was summarized as follows:

- SIR Warning Lamp Status was Off.
- Driver's Belt Switch Circuit Status was Unbuckled.
- Ignition Cycles At Deployment was 0.
- Ignition Cycles At Inspection was 22895.
- Time From Algorithm Enable (AE) To Deployment Command was 18.75 milliseconds (msec).
- Time Between Non-Deployment And Deployment Events was 0 seconds (sec).

The non-deployment event was summarized as follows:

- SIR Warning Lamp Status was Off.
- Driver's Belt Switch Circuit Status was Buckled.
- Ignition Cycles At Non-Deployment was 22725.
- Ignition Cycles At Inspection was 22895.
- Time From AE To Maximum SDM Velocity Change was 5 msec.
- Maximum SDM Recorded Velocity Change was -0.22 mph.
- A Deployment Was Commanded Prior To This Event was No.

The EDR was configured to record 300 msec of longitudinal velocity change during an event. The maximum recorded longitudinal velocity change was -30.72 km/h (-19.09 mph) and occurred from 90 - 110 msec after AE. At 250 msec after AE the recorded velocity change was -23.3 km/h (-14.48 mph). At 260 msec after AE power to the ACM was lost and from 260 - 300 msec after AE the recorded velocity change defaulted to 0.

Child Restraint Systems

Graco TurboBooster BSS

The Saturn's second row left seat position was occupied by a 4-year-old male occupant seated in a Graco TurboBooster forward-facing belt positioning BSS (**Figure 9**). The TurboBooster was intended to be used with or without a detachable high back support with a headrest, depending on the user's age, height and weight. The occupant was using the BSS without a back support at the time of the crash. Proper usage of the BSS required it be used in combination with the vehicle's lap and shoulder belt and not the lap



Figure 9. Graco TurboBooster BSS

belt only.

The TurboBooster model number was 8491QNY and its date of manufacture was July 26, 2007. The BSS was equipped with adjustable padded armrests, a removable padded seat cushion, and retractable cup holders. Based on the interview, the adjustable armrests being used at the time of the crash and were displaced from the BSS during the crash. During the inspection the armrests were found in the vehicle and inserted into the shell for the purpose of assessing their functionality. The shell and armrests did not reveal any damage. The warning and usage label data indicated that the CRS was intended for children who met the following requirements:

- 96.0 - 145.0 cm (38.0 - 57.0 in) in height when used with back support
- 101.0 - 145.0 cm (40.0 - 57.0 in) in height when used without back support
- 3 - 10 years of age when used with the back support
- 4 - 10 years of age when used without the back support
- 13.6 - 45.0 kg (30.0 - 100.0 lb) when used with the back support
- 18.0 - 45.0 kg (40.0 - 100.0 lb) when used without the back support

The child was of the appropriate age and weight, but not of the recommended height, to use the BSS without the back support. He was otherwise properly restrained by the vehicle's lap and shoulder belt.

Graco SnugRide ISS

The Saturn's second row center seat position was occupied by the 12-week-old female occupant seated in a Graco SnugRide rear-facing ISS (**Figure 10**). During the vehicle inspection the ISS was located in the center seat position with the vehicle's lap belt routed through the rear-facing slots. A locking clip was attached to the lap belt webbing near the latch plate.



Figure 10. Graco SnugRide rear-facing ISS

The SnugRide model number was 1760973 and the date of manufacture was November 25, 2009. It was configured with a detachable stay-in-vehicle base that had the same model number and manufacture date as the shell. The ISS was equipped with removable padding, head support, five-point harness system with a retainer clip, multi-position carry handle, adjustable canopy, level indicator, and Lower Anchors and Tethers for Children (LATCH) hardware.

Based on the warning and usage label data, the SnugRide was intended for children who met the following requirements:

- 2.3 - 10.0 kg (5.0 - 22.0 lb) in weight
- 73.0 cm (29.0 in) or less in height

The occupant was the appropriate height and weight for the ISS, and based on the vehicle inspection, it was determined the SnugRide was used in accordance to the manufacturer's recommendations. The ISS based revealed a fracture measuring 8.0 cm (3.1 in) located at the bottom aspect where it interfaced with the base. The ISS exhibited a fracture measuring 4.0 cm (1.6 in) located on the left aspect of the carry handle. The fracture to the stay-in-vehicle base probably resulted from occupant loading and the fracture to the carry handle probably resulted from contact by the occupant in the second row left seat position. When positioned on the vehicle's rear center seat, the ISS seat cushion angle measured 23.0 degrees from horizontal and the seat back measured 47.0 degrees from horizontal. The harness shoulder straps were routed through the bottom set of slots and the retainer clip was positioned 18.0 cm (7.1 in) below the slots.

A locking clip was found attached to the lap belt. However, locking clips are designed to hold the webbing of both the lap and shoulder belts tight until the ELR locks the belt in place and, therefore, the locking clip was of no benefit in this crash.

Vehicle Data - 1979 Chevrolet Blazer

The 1979 Chevrolet K-5 Blazer sport utility vehicle was identified by the Vehicle Identification Number (VIN): CCL189Zxxxxxx and the date of manufacture was unknown. The vehicle was equipped with a 5.7-liter, 8-cylinder engine, automatic transmission, and rear-wheel drive. The vehicle manufacturer recommended P205/75R15 tires for the front and rear and a cold tire pressure of 241 kPa (35 psi) for the front and rear. The vehicle was equipped with Fullrun HP199 275/25ZR26 98WXL tires on the front and rear mounted on aftermarket 5-spoke aluminum rims. The tires were manufactured during June 2009. The specific tire data at the time of the vehicle inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire flat	7 mm (9/32 in)	Yes	Sidewall holed, tread cut, de-beaded
LR	255 kPa (37 psi)	7 mm (9/32 in)	No	None
RR	234 kPa (34 psi)	7 mm (9/32 in)	No	None
RF	Tire flat	7 mm (9/32 in)	No	De-beaded

Vehicle Damage - 1979 Chevrolet Blazer

Exterior Damage

For Event 1, the Chevrolet sustained direct and induced damage to the front plane, and induced damage to the left and top planes. The left front tire was holed, de-beaded, and restricted. The frame was deformed resulting in reduction of the left side wheelbase by 58.0 cm (22.8 in) and of the right side wheelbase by 11.0 cm (4.3 in). The roof was buckled and the front left window frame was deformed outboard.

The direct damage to the front end began at the front left bumper corner and extended 178.0 cm (70.1 in) to the right. The Field L was distributed from bumper corner to bumper corner and measured 162.0 cm (63.8 in). Six crush measurements were taken at bumper level as follows (**Figure 11**): $C_1 = 74.0$ cm (29.1 in), $C_2 = 61.0$ cm (24.0 in), $C_3 = 59.0$ cm (23.2 in), $C_4 = 31.0$ cm (12.2 in), $C_5 = 20.0$ cm (7.9 in), $C_6 = 5.0$ cm (2.0 in). Maximum crush was located at C_1 . Additionally, induced damage extended down the left side 347.0 cm (136.6 in) and ended 25.0 cm (9.8 in) aft of the left rear axle. The CDC for Event 1 was 12FDEW3.



Figure 11. Front end crush profile measurement, 1979 Chevrolet Blazer

After the initial impact, the Chevrolet departed the roadway and overturned onto its left side. The direct damage from the rollover began at the left front bumper corner, extended 339.0 cm (133.5 in), and ended 10.0 cm forward of the left rear axle. There was no residual damage to the greenhouse from the rollover, and the crush damage to the vehicle's sheet metal was masked by the damage sustained in Event 1. The CDC for Event 2 was 00LDAO2.

Occupant Demographics - 1996 Saturn SL1

Driver

Age/Sex:	26 years/Male
Height:	160 cm (63 in)
Weight:	92 kg (203 lb)
Seat type:	Bucket with integral head restraint
Seat track position:	Middle track
Manual restraint usage:	None
Usage source:	Vehicle inspection
Air bags:	Frontal air bag deployed
Alcohol, drug involvement:	Alcohol present, police-reported BAC 0.32 percent; Delta-9 tetrahydrocannabinol (THC) was 4.8 nanograms per milliliter of blood and Delta-9 Carboxyl THC was 22 nanograms per milliliter.
Type of medical treatment:	Transported to local hospital, pronounced deceased in ER

Front Right Occupant

Age/Sex:	19 years/Female
Height:	155 cm (61 in)
Weight:	92 kg (203 lb)
Seat type:	Bucket with integral head restraint
Seat track position:	Middle track
Manual restraint usage:	Lap and shoulder belt
Usage source:	Vehicle inspection
Air bags:	Frontal air bag deployed
Type of medical treatment:	Pronounced deceased on-scene

Rear Left Occupant

Age/Sex:	4 years/Male
Height:	76 cm (30 in)
Weight:	20 kg (44 lb)
Seat type:	60/40 split bench with folding backs
Seat track position:	Not adjustable
Manual restraint usage:	Lap and shoulder belt used with BSS
Usage source:	Vehicle inspection
Air bags:	N/A
Type of medical treatment:	Transported, treated and released

Rear Center Occupant

Age/Sex:	12 weeks/Female
Height:	51 cm (20 in)
Weight:	4 kg (9 lb)
Seat type:	60/40 split bench with folding backs
Seat track position:	Not adjustable

Manual restraint usage:	Lap belt used to secure a rear-facing ISS
Usage source:	Vehicle inspection
Air bags:	N/A
Type of medical treatment:	Transported, treated and released

Occupant Kinematics

Driver

The 24-year-old male driver was seated in an unknown posture and was unrestrained. At impact with the Chevrolet, he was displaced from his seat forward and right in response to the vehicle's 2 o'clock direction of force. The driver's frontal air bag deployed and he loaded the air bag and the steering wheel assembly with his face and head. The steering wheel rim collapsed and the driver sustained multiple face and head injuries including a fractured skull in the occipital and parietal regions, fractured mandible and avulsion of teeth. Additionally, he sustained abrasions and minor lacerations to his face and abrasions to his left shoulder and chest. The driver's head and neck were flexed rearward causing a fractured odontoid and atlanto-occipital dislocation.

The driver's left knee and lower leg contacted the steering column and left lower IP, respectively, sustaining contusions and scuffing the components. The right thigh contacted the center lower IP and sustained contusions. His lower legs contacted the foot controls and sustained bilateral abrasions. This dynamic was made more severe by the vertical intrusion of the floor pan. The vehicle initiated a post-impact counterclockwise rotation and the driver was displaced left. His left upper arm, forearm and hand were contacted by flying glass from the side window and sustained multiple abrasions. The location and posture of the driver when the vehicle came to rest was unknown. He was removed from the vehicle and transported while unconscious, and pronounced deceased 73 minutes post-crash.

Front Right Occupant

The 19-year-old female occupant was seated in an unknown posture and was restrained by the vehicle's lap and shoulder belt. At impact with the Chevrolet, she was displaced forward and right. The frontal air bag deployed and she loaded the safety belt and the air bag, sustaining abrasions to the right shoulder, chest, left breast and abdomen from the safety belt. She sustained C1 and C2 vertebral fractures with dislocation resulting from impact force-related flexion of the head and neck. The occupant's left face and neck were abraded by flying glass from the side window. The occupant compartment was reduced laterally from intrusions of the right door panel and B-pillar, and longitudinally by the right IP. Her seat back was displaced left and rearward by B-pillar intrusion. The occupant's right arm contacted the door panel and sustained a fracture of the humerus at mid-shaft. Her knees and thighs contacted the lower IP causing fractures of both femurs and of the left pelvic ring. Her right lower leg contacted the side panel forward of the A-pillar causing abrasions.

The occupant's left side was probably contacted by the unrestrained driver and she sustained

abrasions to the left upper arm, forearm and hand. The vehicle initiated a post-impact counterclockwise rotation and the occupant was displaced left in her seat where she remained in place until the vehicle came to rest. The front right occupant was pronounced deceased on-scene.

Rear Left Occupant

The 4-year-old male occupant was seated in a Graco TurboBooster forward-facing belt positioning BSS and was restrained by the vehicle's lap and shoulder belt. The safety belt retractor mode and the occupant's posture at the time of the crash was unknown. At impact, the occupant was displaced forward and right in response to the direction of force. His shoulder belt locked and he was held in place on the BSS in his seated position. He loaded the safety belt and sustained a contusion on his right flank. The occupant's head and face probably contacted the ISS secured to the center seat position. He sustained a subdural hematoma and abrasions to the right and posterior scalp, and chin. The ISS revealed a fracture to the left aspect of the carry handle and the shell. The vehicle initiated a post-impact counterclockwise rotation and the occupant was displaced left. He remained in his seated position until the vehicle came to rest. He exited the vehicle with assistance from on-scene responders and was transported to a local hospital where he was treated and released.

Rear Center Occupant

The 12-week-old female occupant was seated in a Graco SnugRide rear-facing ISS and restrained by the SnugRide's 5-point harness system. The ISS was secured to the vehicle's seat by the manual lap belt routed through the ISS's rear-facing slots. At impact, the ISS and the occupant were displaced forward and right. The occupant loaded the ISS harness system and remained in the seat. The occupant seated in the second row left seat position possibly contacted the ISS, fracturing the carry handle and the shell. Additionally, the front right seat back intruded longitudinally into the second row, possibly loading the ISS. Throughout the crash sequence and to final rest the occupant was held in place by the SnugRide's 5-point harness system. The occupant was transported to a local hospital, examined, and released.

Occupant Injuries

Driver

The injury data was obtained from the autopsy.

<u>Injury</u>	<u>AIS 05/Update 08</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Fractures, parietal and occipital skull	150400.2,9	Steering wheel rim/hub/spoke	Probable
Fracture, mandible NFS	250600.1,9	Steering wheel rim/hub/spoke	Probable

Avulsions, right teeth	251406.1,8	Steering wheel rim/hub/spoke	Probable
Dislocation, atlanto-occipital	650208.2,6	Steering wheel rim/hub/spoke	Probable
Fracture, odontoid	650228.3,6	Steering wheel rim/hub/spoke	Probable
Laceration, minor (3.0 cm), chin	210602.1,8	Frontal air bag	Probable
Laceration, minor, lips	210602.1,8	Frontal air bag	Certain
Abrasions, right face (cheek)	210202.1,1	Frontal air bag	Certain
Abrasions, forehead	210202.1,7	Frontal air bag	Certain
Laceration, right auditory canal (otorrhagia)	240204.1,1	Unknown	Unknown
Abrasion, right hip	810202.1,1	Center console	Probable
Abrasions, left shoulder to chest	410202.1,2	Frontal air bag	Probable
Abrasions, left upper arm, elbow and hand	710202.1,2	Flying glass	Probable
Abrasions, left knee	810202.1,2	Steering column	Certain
Abrasions, right thigh	810202.1,1	Center lower IP	Probable

Front Right Occupant

The injury data was obtained from the autopsy.

<u>Injury</u>	<u>Injury Severity</u> AIS 05/Update 08	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Abrasions, right face, nose, upper lip and chin	210202.1,1	Flying glass	Probable
Fracture with dislocation NFS, cervical spine, C1, C2	650216.2,6 650216.2,6	Impact forces	Probable
Abrasions (dicing injury), right neck	310202.1,1	Flying glass	Probable

Abrasions, right shoulder and chest	410202.1,1	Safety belt	Certain
Abrasion, left breast	410202.1,2	Safety belt	Probable
Abrasions, abdomen	510202.1,4	Safety belt	Certain
Fracture, pelvic ring, left ischial pubis	856151.2,2	Right lower IP	Probable
Abrasions (dicing injury) right upper arm	710202.1,1	Flying glass	Probable
Abrasions and lacerations, minor, left upper arm, forearm and hand	710202.1,2	Other occupant, driver	Possible
Fracture, comminuted, right proximal femur	853111.3,1	Right lower IP	Probable
Laceration, minor (1.2 cm), right thigh	810602.1,1	Door panel, hardware forward lower quadrant	Probable
Abrasions and contusions, right lower leg	810202.1,1 810402.1,1	Side panel forward of A-pillar	Probable
Fracture, comminuted, left proximal femur	853111.3,2	Right lower IP	Probable
Abrasions, posterior left thigh	810202.1,2	Center console	Probable
Abrasions, left lower leg	810202.1,2	Right lower IP	Probable

Rear Left Occupant

The injury data was obtained from the medical records and the interview.

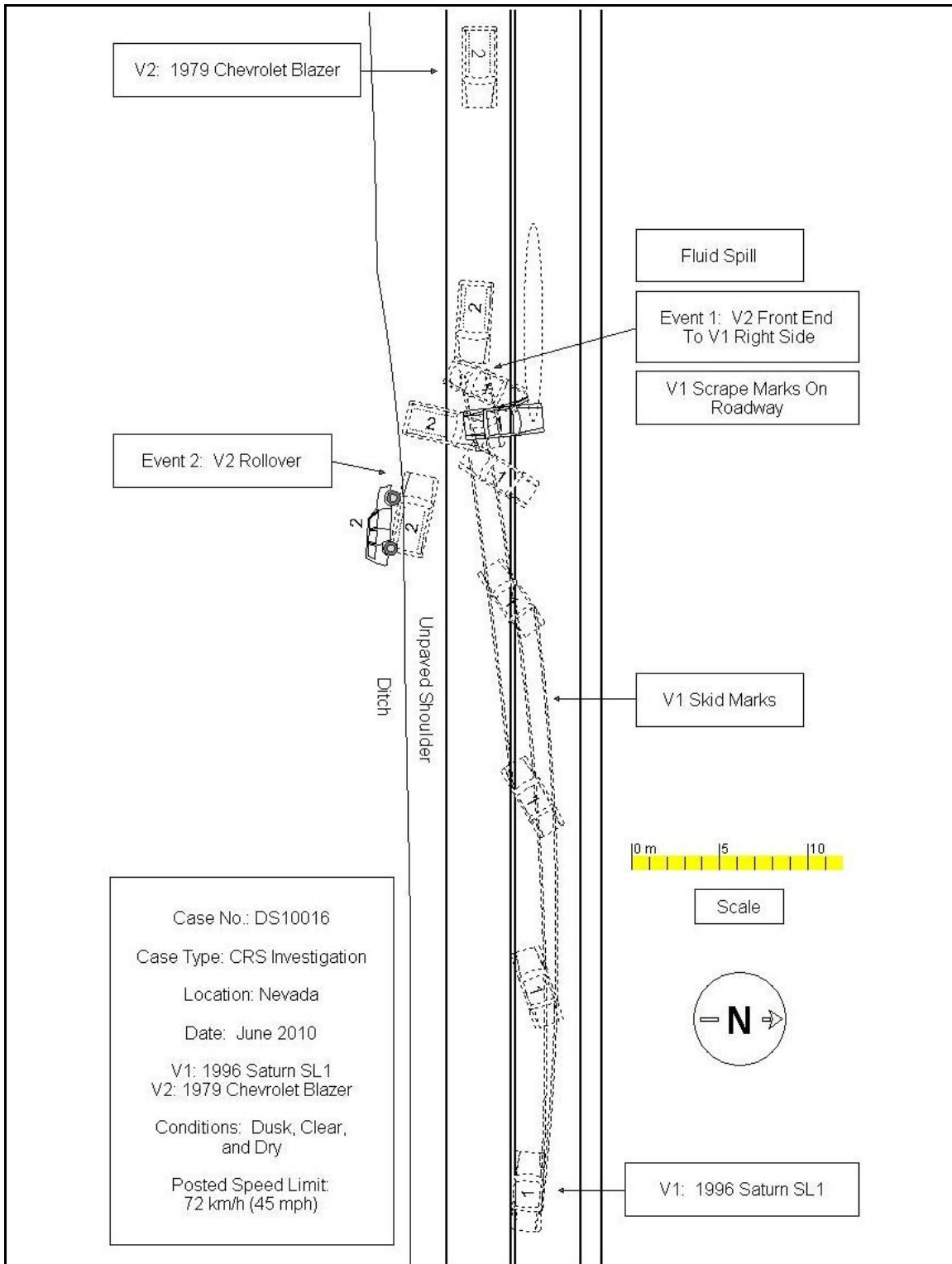
<u>Injury</u>	<u>Injury Severity</u> AIS 05/Update 08	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Subdural hematoma NFS	140650.3,6	Other interior object, ISS in center seat	Probable
Abrasion, right scalp	110202.1,1	Other interior object, ISS in center seat	Probable
Abrasion, posterior scalp	110202.1,6	Other interior object, ISS in center seat	Probable

Abrasion, chin	210202.1,8	Other interior object, ISS in center seat	Probable
Abrasion, posterior neck	310202.1,6	Other interior object, ISS in center seat	Probable
Contusion, right flank	510402.1,1	Safety belt	Certain

Rear Center Occupant

Based on the occupant's medical records and the interview she was not injured.

Attachment 1. Scene Diagram



Attachment 2. Bosch CDR Report

IMPORTANT NOTICE: Robert Bosch LLC and the manufacturers whose vehicles are accessible using the CDR System urge end users to use the latest production release of the Crash Data Retrieval system software when viewing, printing or exporting any retrieved data from within the CDR program. Using the latest version of the CDR software is the best way to ensure that retrieved data has been translated using the most current information provided by the manufacturers of the vehicles supported by this product.

CDR File Information

User Entered VIN	1G8ZH528XTZ*****
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	
Saved on	Tuesday, August 10 2010 at 10:36:39 AM
Collected with CDR version	Crash Data Retrieval Tool 3.3
Reported with CDR version	Crash Data Retrieval Tool 3.5.1
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). The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded longitudinal velocity change. 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. 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. The SDM records the first 300 milliseconds of Vehicle Longitudinal Velocity Change after Algorithm Enable. The maximum value that can be recorded for Vehicle Longitudinal Velocity Change is 56 MPH. Velocity Change data is displayed in SAE sign convention.

-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit.

-The Time between Non-Deployment and Deployment 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. An indication of a loss of power would be if the ignition cycles at the event is recorded as zero. Data recorded after that may not be reliable, such as Time Between Non-Deployment and Deployment Events and Driver Belt Switch Circuit Status.

-In some cases, if the Non-Deployment Event is closely followed by a Deployment Event, the EDR may record all of the SDM Recorded Vehicle Longitudinal Velocity Change values as zero MPH.

-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:

-The Driver's Belt Switch Circuit is wired directly to the SDM.

01032_SD MR_r001

System Status At Deployment

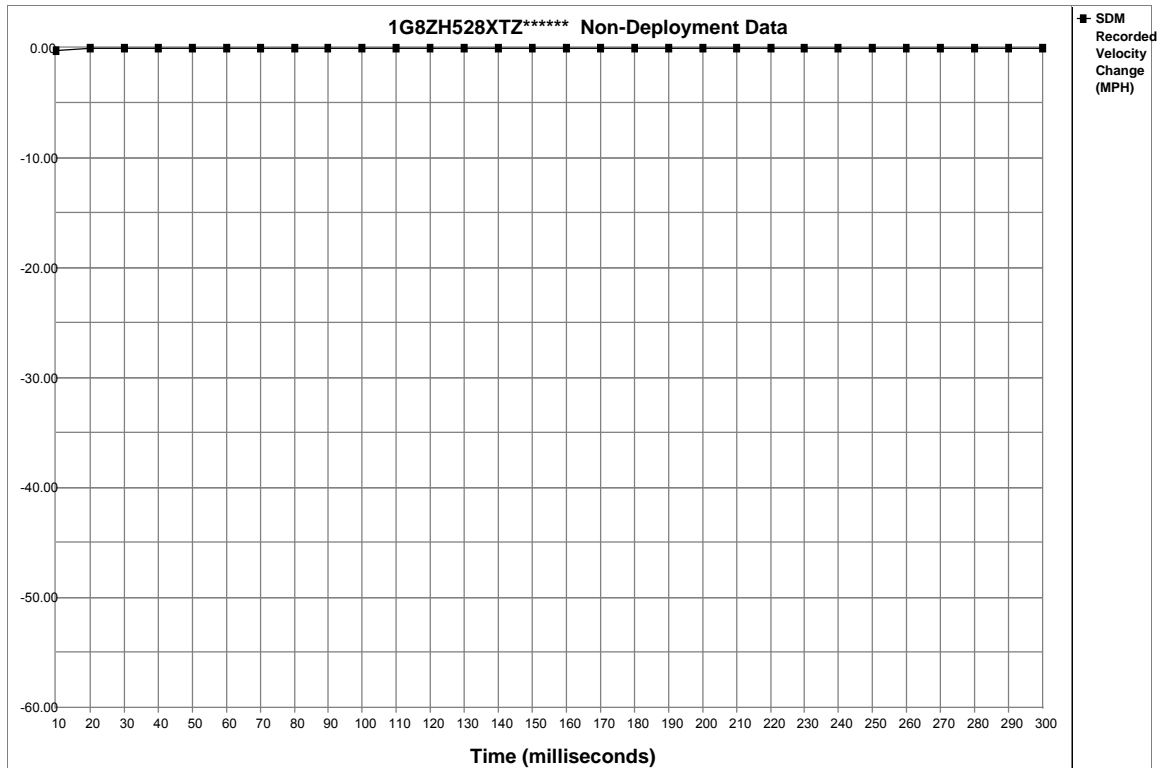
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Deployment	0
Ignition Cycles At Investigation	22895
Time From Algorithm Enable To Deployment Command (msec)	18.75
Time Between Non-Deployment And Deployment Events (sec)	0



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-1.32	-2.63	-6.58	-10.75	-12.51	-16.89	-17.33	-17.55	-19.09	-19.09	-19.09	-18.65	-17.99	-16.89	-15.80
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	-15.80	-15.58	-15.36	-15.36	-15.36	-15.14	-14.92	-14.70	-14.48	-14.48	0.00	0.00	0.00	0.00	0.00

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	22725
Ignition Cycles At Investigation	22895
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	5
Maximum SDM Recorded Velocity Change (MPH)	-0.22
A Deployment was Commanded Prior to this Event	No



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.22	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00