CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CHILD SAFETY SEAT/SIDE IMPACT INFLATABLE CURTAIN DEPLOYMENT INVESTIGATION

CASE NO.: CA03-058

LOCATION: STATE OF MASSACHUSETTS

VEHICLE: 2003 SATURN L200

CRASH DATE: OCTOBER 2003

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are 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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. CA03-058	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Child Safety Seat/Side Impact Inflatable Curtain Deployment Investigation Vehicle: 2003 Saturn L200 Location: State of Massachusetts		*5. Report Date*: August 2005	
		6. Performing Organization Code	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0160	
		11. Contract or Grant No. DTNH22-01-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: October 2003	
		14. Sponsoring Agency Code	
15. Supplementary Note On-site investigation focused on the performance of a Belt Positioning Booster (BPB) seat and the left and right side impact Inflatable Curtains (IC) that deployed in a 2003 Saturn L200.			
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17. Key Words Inflatable Curtain Air Bag Deployment Belt Positioning Booster Safety Seat		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 12	*22. Price*

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LOCATION: STATE OF MASSACHUSETTS
VEHICLE: 2003 SATURN L200
CRASH DATE: OCTOBER 2003

BACKGROUND

This on-site investigative effort focused on the performance of a backless Belt Positioning Booster (BPB) seat and the left and right side impact Inflatable Curtains (IC) that deployed in a 2003 Saturn L200. The Saturn was occupied by a 34-year-old restrained female driver and a 4-year-old male rear right child passenger who was positioned in a BPB and restrained by the vehicle's manual 3-point lap and shoulder belt. The Saturn was struck on the right side aspect by a 2000 Lexus ES300 in an intersection crash. The initial right side impact was sufficient to deploy the right side IC and both frontal air bags. The Saturn was deflected laterally to the left into the front left corner of a 1984 Mack concrete delivery truck that was stopped in the intersection waiting to initiate a left turn **(Figure 1)**. The secondary left side impact resulted in the deployment of the left side IC and significant left side intrusion. The driver of the Saturn did not sustain injury. The 4-year-old male child passenger of the Saturn sustained a right hip contusion and a right shoulder contusion. Both occupants were transported by ambulance to a local hospital for evaluation and released.

Figure 1. On-scene photograph of the damaged Saturn L200

This crash was identified by the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) due to the use of the BPB. An on-site investigation was assigned to the General Dynamics SCI team on October 17, 2003. The inspections of the vehicles were completed October 21st and 22nd and the EDR in the Saturn L200 was downloaded. The BPB was inspected during the in-person interview on October 21st.

SUMMARY

CRASH SITE

This three-vehicle crash occurred during the daylight hours of October 2003 in the State of Massachusetts. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The crash occurred at a four-leg intersection of two arterial roadways. Both roadways were configured with one travel lane in each direction separated by double-yellow centerlines and bordered by concrete curbs. A raised curbed gore was present on the southeast corner of the intersection to direct the flow of northbound traffic initiating right turns onto the eastbound lane. The roadside environment consisted of commercial properties. A small community park was located on the southwest corner of the intersection. Three-phase traffic signals were present on poles located on the street corners that controlled the traffic flow through the intersection. The posted speed limit for the east/west roadway was 56 km/h (35 mph). The posted speed limit for

the north leg of the intersection was 56 km/h (35 mph) and the posted speed limit for the south leg of the intersection was 40 km/h (25 mph). The scene schematic is included as **Figure 19** of this report.

VEHICLE DATA – 2003 SATURN L200

The 2003 Saturn L200 was identified by the Vehicle Identification Number (VIN): 1G8JU54F33Y (production sequence omitted). The vehicle was a four-door sedan that was equipped with a 2.2 liter, 4-cylinder engine, front wheel-drive, automatic transmission, power-assisted front disc and rear drum brakes with ABS, a traction control system, daytime running lights, power steering, and a tilt steering wheel. The steering wheel was in the full-down position at the time of the vehicle inspection. The Saturn's odometer could not be read due to the lack of electrical power to the vehicle, but the driver estimated that the odometer read approximately 25,740 km (16,000 miles). The Saturn was a rental vehicle that had been driven by the female driver for approximately five weeks prior to the crash. The Saturn was configured with Firestone Affinity tires on the front and left rear and Uniroyoal Tiger Paw on the right rear size, P195/65R15 mounted on OEM steel wheels. The manufacturer's recommended tire pressure was unknown. The specific tire data at the time of the SCI inspection was follows:

Position	Tire	Measured Pressure	Measured Tread	Damage
LF	Firestone Affinity Touring T2	199.9 kpa (29.0 psi)	6.4 mm (8/32")	None
LR	Firestone Affinity Touring T2	199.9 kpa (29.0 psi)	6.4 mm (8/32")	None
RF	Firestone Affinity Touring T2	196.5 kpa (28.5 psi)	5.6 mm (7/32")	None
RR	Uniroyal Tiger Paw	179.3 kpa (26.0 psi)	7.1 mm (9/32")	None

The seating positions in the Saturn were configured with front bucket seats with four-way adjustable head restraints and a rear bench seat with split folding backs with integral head restraints. The front seat head restraints were in the full-down positions and both front seat backs were slightly reclined. The driver's seat track was adjusted 2.5 cm (1.0") rear of full-forward and 16.5 cm (6.5") forward of full rear.

VEHICLE DATA – 2000 LEXUS ES300

The 2000 Lexus ES300 was identified by the VIN: JT8BF28G8Y0 (production sequence omitted). The vehicle was a four-door sedan that was equipped with a 3.0-liter, V-6 engine, a four-speed, automatic transmission, a traction control system, four-wheel disc brakes with four-wheel ABS, power steering, and a tilt steering wheel. The ES300 was also equipped with daytime running lights and automatic dimming side view and rear view mirrors. The ES300 was configured with P205/60R16 tires that were mounted on alloy wheels. The manufacturer's recommended tire pressure for up to four occupants was 180 kpa (26 psi). The recommended tire pressure for the vehicle capacity weight was 220 kpa (32 psi). The specific tire data was follows:

Position	Tire	Measured Pressure	Measured Tread	Damage
LF	Michelin Energy MXV4 Plus	224.1 kpa (32.5 psi)	7.9 mm (10/32”)	None
LR	Bridgestone Potenza	234.4 kpa (34.0 psi)	5.6 mm (7/32”)	None
RF	Michelin Energy MXV4 Plus	213.7 kpa (31.0 psi)	7.9 mm (10/32”)	None
RR	Bridgestone Potenza	227.5 kpa (33.0 psi)	4.8 mm (6/32”)	None

VEHICLE DATA – 1984 MACK CONCRETE DELIVERY TRUCK

The 1984 Mack concrete delivery truck **(Figure 2)** was identified by the VIN: 1M2B180C4EA (production sequence omitted). The truck was a 6 x 4, model DM690SX incomplete chassis, with a 455 cm (179”) wheelbase and equipped with a concrete mixer drum. The truck was configured with a 6-cylinder, 672 cubic inch diesel engine, a 5-speed manual transmission, a dual air brake system, and 12.00 R24 tires on 20 cm (8”) cast steel spoke wheels. The truck was also configured with an extended front bumper that measured 241.3 cm (95.0”) in width, 29.8 cm (11.8”) in height, and 66.7 cm (26.3”) in depth. The face of the bumper was constructed of 3 mm (1/8”) thick steel, which measured 127.0 cm (50.0”) in width across the frame rails. The outboard aspects were angled rearward starting 73.7 cm (29.0”) inboard of the edge. A hydraulic pump was located in the center aspect of the bumper and the center of the bumper was reinforced with 6 mm (1/4”) thick steel beams. The bumper height measured 72.4 cm (28.5”), and the front overhang of the truck measured 158.0 cm (62.3”).

Figure 2. 1984 Mack concrete delivery truck

The unloaded weight of the concrete delivery truck was 15,105 kg (33,300 lb). At the time of the crash, the truck was loaded with eight yards of concrete, weighing 13,426 kg (29,600 lb), which resulted in a total weight of 28,531 kg (62,900 lb).

CRASH SEQUENCE

Pre-Crash

The 34-year-old female driver of the Saturn L200 was operating the vehicle in a southbound direction on approach to the four-leg intersection. The traffic signal for north/south traffic was in the red phase and the driver brought the vehicle to a controlled stop behind a non-contact vehicle, also stopped at the intersection **(Figure 3)**. The 1984 Mack concrete delivery truck was traveling southbound and the driver had brought the vehicle to a stop on the north leg of the intersection. The 68-year-old female driver of the Lexus was

Figure 3. Southbound approach for the Saturn L200

operating the vehicle in an eastbound direction on approach to the intersection **(Figure 4)** when the traffic signal cycled to red for east/west traffic. When the traffic signal cycled to the green phase for north/south traffic, the non-contact vehicle proceeded into the intersection and made a left turn. The driver of the Saturn proceeded into the intersection but did not detect the Lexus approaching from the right. The pre-crash data downloaded from the Saturn's EDR supported the pre-crash scenario and reported a vehicle speed of 5 km/h (3 mph) four seconds before impact and a vehicle speed of 23 km/h (14 mph) two seconds prior to impact. Six seconds pre-crash through ten seconds pre-crash showed a vehicle speed of zero for the Saturn. The concrete delivery truck proceeded slowly into the intersection and stopped while the driver waited for northbound traffic to clear the intersection. The driver of the Lexus disregarded the red traffic signal for eastbound traffic and continued into the intersection.

Figure 4. Eastbound approach for the Lexus ES300.

Crash

The front of the Lexus impacted the right side passenger area of the Saturn. The impact resulted in moderate damage to both vehicles and was sufficient to deploy the right side IC in the Saturn and the frontal redesigned air bag system in the Lexus. The longitudinal deceleration of the Saturn was sufficient to also deploy the Saturn's frontal air bag system. The EDR-reported Time From Algorithm Enable to Deployment Command Criteria Met was 46 milliseconds, and the maximum SDM Recorded Velocity Change was -11.27 km/h (-7.00 mph), 80 through 110 milliseconds into the crash. The damage algorithm of the WinSMASH program computed a total delta-V of 22.0 km/h (13.7 mph) for the Saturn L200 and a total delta-V of 20.0 km/h (12.4 mph) for the Lexus ES300 based on the respective crush profiles. The longitudinal and lateral delta-V's were –7.5 km/h (-4.7 mph) and –20.7 km/h (-12.8 mph), respectively for the Saturn. The impact caused both vehicles to rotate in a clockwise direction. The Saturn was deflected laterally into the stationary Mack concrete delivery truck and the left side passenger area of the Saturn struck the front bumper of the truck. The impact was sufficient to deploy the left side IC and resulted in moderate left side damage to the Saturn and due to the bumper height of the truck, moderate intrusion into the Saturn at the beltline. The damage algorithm of the WinSMASH program computed a total delta-V of 27.0 km/h (16.8 mph) for the left side secondary impact with the stationary truck.

Post-Crash

The left side aspect of the Saturn came to rest against the front aspect of the concrete delivery truck and the front of the Lexus came to rest against the right side of the Saturn **(Figure 5)**. The child passenger removed the safety belt and was removed from the vehicle by rescue personnel through the backlight. The driver of the Saturn did not sustain injury and removed the safety

Figure 5. On-scene photograph looking northbound showing final rest positions

belt but could not exit the vehicle as the Saturn was captured between the Lexus and the Mack truck, which caused the doors to be jammed shut. The Lexus was moved rearward away from the right side aspect of the Saturn and the front driver attempted to the exit the vehicle through the right front door. Since the right front door was jammed shut, the driver crawled into the rear seat and exited the vehicle through the right rear door that was pried open by rescue personnel. The driver of the Lexus was removed from the vehicle by rescue personnel. The driver of the concrete delivery truck was not injured and exited the vehicle under his own power. The Saturn and Lexus were towed from the scene and the Mack concrete delivery truck was driven from the scene to its destination.

VEHICLE DAMAGE

Exterior Damage – 2003 Saturn L200

The 2003 Saturn sustained moderate left and right side damage as a result of the multiple impacts. As **Figure 6** illustrates, the direct contact damage on right side plane began 3.8 cm (1.5”) aft of the leading edge of the right front door and extended rearward 167.6 cm (66.0”). Paint transfers were present along the direct damage length and extended 47.0 cm (18.0”) vertically above the sill. The right front plastic door panel was fractured and the right rear door panel was completely separated. The sill also exhibited paint transfers and lateral crush. The combined direct and induced damage along the right side plane began 45.5 cm (17.9”) aft of the right front axle and extended 189.2 cm (74.5”) rearward. The maximum crush located at the center of the right front door and measured 34.0 cm (13.4). Deflection points were present forward of the right front door and aft of the right rear door and the right rear door glazing was disintegrated. The Collision Deformation Classification (CDC) for the initial right side impact with the Lexus ES300 was 02-RPEW-3. Six crush measurements were documented along the right side composite body panels, 10.2 cm (4.0”) above the sill, and were as follows: C1 = 0.0 cm, C2 = 21.0 cm (8.3”), C3 = 30.2 cm (11.9”), C4 = 31.8 cm (12.5”), C5 = 17.8 cm (7.0”), C6 = 5.1 cm (2.0”).

Figure 6. Right side damage to the Saturn L200

The Saturn L200 also sustained moderate left side damage **(Figure 7)** as a result of the impact with the concrete delivery truck. The direct contact damage on the left side began 73.7 cm (29.0”) aft of the leading edge of the left front door and extended 149.9 cm (59.0”) rearward. Red paint transfers from the bumper of the concrete delivery truck began 14.0 cm (5.5”) forward of the rear edge of the left front door and extended rearward to the left C-pillar. The paint transfers began 7.6 cm (3.0”) below the beltline on the left front door and began 27.9 cm (11.0”) below the beltline on the left rear door. The paint transfers

Figure 7. View of the left side damage to the Saturn L200

extended vertically and terminated 10.2 cm (4.0”) below the left roof side rail. All of the left side glazing disintegrated from the impact and the maximum lateral crush measured 47.6 cm (18.8”), and was located 9.5 cm (3.8”) above the beltline at the left B-pillar. A tire scuff mark was present on the left front door 73.7 cm (29.0”) aft of the leading edge as a result of direct contact with the concrete delivery truck’s left front tire. The scuff mark measured 40.6 cm (16.0”) in height and measured 3.8 cm (1.5”) wide. The combined direct and induced damage began at the forward aspect of the left front door and extended 251.5 cm (99.0”) rearward. The lateral crush near the beltline on the left rear door resulted in the outward deflection of the bottom aspect of the composite door panel. The roof side rail was buckled inward due to the beltline crush. The CDC for the left side impact with the concrete delivery truck was 09-LPHW-3. Six crush measurements were documented along the left side plane at the beltline and were as follows: C1 = 0.0 cm, C2 = 10.7 cm (4.2”), C3 = 33.5 cm (13.2”), C4 = 34.8 cm (13.7”), C5 = 7.1 cm (2.8”), C6 = 0.0 cm.

Interior Damage – 2003 Saturn L200

The 2003 Saturn L200 sustained moderate interior damage as a result of passenger compartment intrusion **(Figure 8)**. The left front, left rear, and right front doors were jammed shut. The right rear door had been pried open by rescue personnel. A faint scuff mark was present on the left side of the center instrument panel from probable contact with the driver’s right knee. The rear view mirror was displaced CW. The right outboard aspect of the front right passenger’s seat back exhibited a scuff mark that measured 5.1 cm (2.0”) in width and 6.4 cm (2.5”) in height from contact with the intruded right B-pillar. The interior aspect of the right rear door was deformed as a result of intrusion, and two areas of scuff marks were present below the armrest from contact with the front right corner of the BPB.

Figure 8. View through the backlight of the Saturn L200 showing lateral intrusions

The specific intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
LF	Left front door	25.4 cm (10.0”)	Lateral
LF	Left roof side rail	27.9 cm (11.0”)	Lateral
LF	Left A-pillar	5.1 cm (2.0”)	Lateral
LF	Left B-pillar	49.5 cm (19.5”)	Lateral
LF	Left roof side rail (at B-pillar)	27.3 cm (10.8”)	Lateral
LF	Left roof side rail	10.2 cm (4.0”)	Vertical
CF	Driver’s seat	8.9 cm (3.5”)	Lateral
RF	Center console	5.1 cm (2.0”)	Lateral
RF	Right front door	22.9 cm (9.0”)	Lateral

RF	Right roof side rail	7.0 cm (2.8”)	Lateral
RF	Right roof side rail	5.1 cm (2.0”)	Vertical
RF	Right B-pillar	25.4 cm (10.0”)	Lateral
RF	Right sill	14.0 cm (5.5”)	Lateral
LR	Left rear door	38.7 cm (15.3”)	Lateral
LR	Left roof side rail	30.5 cm (12.0”)	Lateral
LR	Left C-pillar	19.1 cm (7.5”)	Lateral
LR	Left roof side rail	14.0 cm (5.5”)	Vertical
RR	Right rear door	27.9 cm (11.0”)	Lateral
RR	Right roof side rail	7.6 cm (3.0”)	Lateral
RR	Right roof side rail	5.1 cm (2.0”)	Vertical

Exterior Damage – 2000 Lexus ES300

The 2000 Lexus ES300 sustained moderate frontal damage **(Figure 9)** as a result of the impact with the Saturn. The direct damage began at the front right bumper corner and extended laterally 161.3 cm (63.5”) across the entire bumper. Lateral paint transfers and scuff marks were present along the entire width of the front bumper fascia. The entire bumper fascia was shifted 5.1 cm (2.0”) to the right. The combined direct and induced damage involved the entire frontal width of the Lexus. The hood was buckled slightly rearward and the right front fender was bowed outward. The CDC for the frontal impact with the Saturn was 11-FDEW-1. Six crush measurements were documented along the front bumper and were as follows: C1 = 3.2 cm (1.2”), C2 = 2.5 cm (1.0”), C3 = 2.2 cm (0.9”), C4 = 2.5 cm (1.0”), C5 = 2.5 cm (1.0”), C6 = 5.1 cm (2.0”).

Figure 9. Damaged 2000 Lexus ES300

Exterior Damage – 1994 Mack Concrete delivery Truck

The 1984 Mack concrete delivery truck sustained superficial scuff marks on the front bumper as a result of the frontal impact with the left side aspect of the Saturn. The truck’s front bumper had been repainted at the time of inspection.

MANUAL RESTRAINT SYSTEMS – 2003 SATURN L200

The 2003 Saturn L200 was configured with manual 3-point lap and shoulder belts for the driver and front right passenger seating. The driver’s safety belt **(Figure 10)** was configured with a sliding latch plate, an Emergency Locking Retractor (ELR), and an adjustable D-ring that was located 2.5 cm (1.0”) below the full-up position. The front right safety belt was configured with a sliding

Figure 10. View of driver's safety belt

latch plate, a switchable ELR/Automatic Locking Retractor (ALR), and an adjustable D-ring. Each D-ring was located behind, and attached to, a vertically adjustable plastic cover on each interior B-pillar. The rear seating positions were equipped with manual 3-point lap and shoulder belts. Each rear safety belt was configured with a sliding latch plate and a switchable ELR/ALR retractor. The outboard rear D-rings were located 10.2 cm (4.0") above the rear seat back.

The driver was utilizing the safety belt at the time of the crash, which was supported by the vehicle inspection and the EDR output. Following the crash, the driver released the safety belt buckle and exited the vehicle. The safety belt partially retracted onto the ELR retractor and would not extend at the time of the SCI inspection. Minor abrasions were present on the plastic-covered latch plate from occupant loading. The D-ring could not be evaluated for abrasions due to intrusion.

The rear right safety belt **(Figure 11)** was used to restrain the 4-year-old child in the BPB. Subtle corrugations were present in the safety belt webbing, possibly from prior use or minor occupant loading in this crash. The corrugations began 57.2 cm (22.5") above the lower anchor and extended 40.6 cm (16.0") up the webbing.

Figure 11. View of rear right safety belt

BELT POSITIONING BOOSTER SEAT – COSCO HIGH RISE

The Cosco High Rise BPB was positioned on the right side of the rear bench seat in the Saturn L200 **(Figure 12)**. The model number was 22-298-HRS, the date of manufacture was August 07, 2002, and the BPB was not on the NHTSA recall list. The BPB was a backless booster that was configured with an adjustable shoulder belt positioner that consisted of a clip on the end of a strap attached behind the booster base. The adjuster was designed to adjust the angle of the shoulder belt by routing the shoulder belt through the clip and adjusting the strap length so the shoulder belt could be centered across the child's chest. The manufacturer's label stated that the BPB was rated for children who weighed 14 – 45 kg (30 – 100 lb) and whose height was less than 132 cm (52"), as long as the midpoint of the child's head was not above the vehicle seat back. The 4-year-old child positioned in the BPB was within the recommended height and weight guidelines.

Figure 12. BPB in position with the vehicle's safety belt

The BPB was purchased new and had been used daily for approximately one year prior to the crash. The driver placed the BPB into the vehicle prior to the crash and restrained the child passenger using the vehicle's manual 3-point lap and shoulder belt, and removed the slack in the

belt by pulling on the webbing. The BPB's shoulder belt adjuster strap was not utilized. The BPB did not sustain damage as a result of the crash.

FRONTAL REDESIGNED AIR BAG SYSTEM - 2003 SATURN L200

The 2003 Saturn L200 was equipped with redesigned frontal air bags for the driver and front right passenger positions. The frontal air bags deployed as a result of the longitudinal deceleration during the initial right side impact with the Lexus. The driver's air bag deployed from the steering wheel hub through symmetrical I-configuration module cover flaps. The cover flaps measured 8.3 cm (3.3") in height and 10.8 cm (4.3") in width. The driver's air bag **(Figure 13)** measured 61.0 cm (24.0") in diameter in its deflated state. An apparent lipstick transfer was present on the face of the air bag, 2.5 cm (1.0") to the right of the vertical centerline and 9.5 cm (3.8") above the horizontal centerline. A large area of makeup transfer was also present on the face of the air bag. The makeup transfer began 2.5 left of the vertical centerline and extended 16.5 cm (6.5") in width. It began at the horizontal centerline and extended 19.7 cm (7.8") downward. A faint body fluid (blood) transfer was present on the circumferential seam at the vertical centerline.

Figure 13. Deployed driver's air bag (steering wheel rotated 60 degrees CW)

The front right passenger's air bag deployed from a mid-mount module configured with a rectangular cover flap hinged at the top aspect. The vinyl cover flap measured 30.5 cm (12.0") in width and 21.6 cm (8.5") in height. Due to the lateral intrusion at the right A-pillar, the vinyl cover of the instrument panel continued to tear beyond the outline of the cover flap, and the right corner of the instrument panel intruded under the open cover flap **(Figure 14)**. An additional tear that measured 15.3 cm (6.0") in length radiated forward and to the left from the bottom left aspect of the cover flap. A 5.1 cm (2.0") tear radiated forward from the top right corner of the cover flap. The front right passenger's air bag **(Figure 15)** measured 40.6 cm (16.0") in width and 66.0 cm (26.0") in height in its deflated state.

Figure 14. Front right passenger's air bag cover

Figure 15. Deployed front right passenger's air bag

SIDE IMPACT INFLATABLE CURTAINS – 2003 SATURN L200

The 2003 Saturn L200 was also equipped with a side impact Inflatable Curtains (IC). The right and left side IC's deployed as a result of the right side impact with the Lexus and the left side impact with the concrete delivery truck, respectively. The IC's **(Figures 16 and 17)** deployed downward from the roof side rails through the separation of the outboard edges of the headliner between the A- and C-pillars. The headliner separation measured 127.0 cm (50.0") in length and 7.6 cm (3.0") laterally on each side. Both IC's measured 162.6 cm (64.0") in length and 40.6 cm (16.0") in height in their deflated state. The IC's were tethered on the front and rear outboard aspects. The front tether was triangular in shape and was attached via two stitch points on the outboard aspect of each IC. The tether was tapered at the forward aspect and was anchored to a square plastic tube that measured 1.3 cm (0.5") in width and extended 23.5 cm (9.3") rearward from each A-pillar. A 17.8 cm (7.0") long tether that measured 1.3 cm (0.5") in width was stitched to the rear outboard aspect of each IC and was anchored to the interior C-pillars.

Figure 16. View from backlight showing left and right side IC's

Figure 17. Deployed right side IC

The stored gas inflators for the IC's were mounted longitudinally on the center aspect of the D-pillars beneath the interior trim panels.

There was no occupant contact evidence on either inboard aspect of the IC's. The outboard aspect of the left IC exhibited scuff marks and a small paint transfer in the area of the left rear door window from direct contact with the concrete delivery truck's bumper **(Figure 18)**.

Figure 18. Outboard view of left IC showing areas of scuff marks

EVENT DATA RECORDER – 2003 SATURN L200

The Saturn L200 was equipped with an Event Data Recorder that was located in the Saturn's Sensing and Diagnostic Module (SDM). The SDM was mounted on the floor under the rear aspect of the center console. The Saturn's EDR was downloaded via a direct connection to the SDM during the vehicle inspection. The EDR summary showed a Deployment Event resulting from the right side impact with the Lexus and a Non-Deployment Event that was recorded 196 ignition cycles prior to the crash. The Saturn was a rental vehicle, therefore, additional information regarding the previous Non-Deployment Event was not known.

The Deployment Event indicated the frontal air bag system was commanded to deploy as a result of the longitudinal deceleration the Saturn experienced during the initial impact with the Lexus. The SDM Recorded Maximum Velocity Change was -11.27 km/h (-7.00 mph). The data also indicated that the SIR Warning Lap Status was "Off", the Driver's Belt Switch Circuit Status was "Buckled", the Time From Algorithm Enable to Deployment Command Criteria Met was 46 milliseconds, that the brake was not applied, and that there was no additional Non-Deployment record associated with this crash. This EDR recorded ten seconds of pre-crash data that were reported in two-second intervals. This data indicated that the Saturn was stopped until four seconds prior to impact, when the Saturn accelerated into the intersection. The Saturn was traveling 23 km/h (14 mph) two seconds before impact. The downloaded EDR data is included as **Attachment A** at the end of this report.

OCCUPANT DEMOGRAPHICS – 2003 SATURN L200

Driver

Age/Sex:	34-year-old female
Height:	157 cm (62")
Weight:	54 kg (120 lb)
Seat Track Position:	adjusted 2.5 cm (1.0") rear of full-forward and 16.5 cm (6.5") forward of full-rear
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, interview
Eyewear:	None
Type of Medical Treatment:	Did not sustain injury but was transported by ambulance to a local hospital for evaluation and released

Driver Kinematics

The 34-year-old female driver had the driver's seat adjusted to 2.5 cm (1.0") rear of full-forward and 16.5 cm (6.5") forward of full rear and was seated in a slightly reclined posture. She was restrained by the manual 3-point lap and shoulder belt. At impact with the Lexus, the frontal air bag system and right side IC deployed. She initiated a forward and lateral trajectory to the right and loaded the deployed driver's air bag, evidenced by makeup transfers. The use of the safety belt prevented significant lateral movement. She rebounded to the left as the Saturn was redirected laterally. At the secondary impact with the concrete delivery truck, the left IC deployed and the driver was redirected laterally to the left. She loaded the safety belt and the deployed IC, which mitigated direct contact with the intruded bumper of the truck. The driver

rebounded to the right and came to rest in the driver's seat. She did not sustain injury, but was transported by ambulance to a local hospital where she was evaluated and released.

Rear Right Passenger

Age/Sex:	4-year-old male
Height:	109 cm (43")
Weight:	22 kg (48 lb)
Seat Track Position:	Fixed
Manual Restraint Use:	Vehicle's manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, interview with parent
Eyewear:	None
Type of Medical Treatment:	Transported by ambulance to a local hospital and treated and released

Rear Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Right shoulder contusion	Minor (790402.1,1)	Shoulder belt webbing
Right hip contusion	Minor (890402.1,1)	Probably right aspect of CSS

Injury source: Interview with parents

Rear Right Passenger Kinematics

The 4-year-old male child passenger was seated in the BPB on the right aspect of the rear bench seat and was restrained by the manual 3-point lap and shoulder belt. At impact with the Lexus, the right side IC deployed and the child initiated a forward and lateral trajectory. The driver stated that the BPB moved forward on the vehicle seat cushion during the crash. The child sustained a right shoulder contusion from loading the shoulder belt and a right hip contusion from contact with the right side aspect of the BPB. His head contacted the deployed IC, which mitigated contact with the disintegrated glazing and intruding components. He rebounded to the left and was redirected to the left as the Saturn impacted the concrete delivery truck. The use of the BPB and safety belt prevented additional lateral movement. The child came to rest in the BPB, which was described by the driver as being "half off the vehicle seat" post-crash. The child removed the safety belt himself and was removed from the vehicle by rescue personnel through the backlight. He was transported by ambulance to a local hospital where he was treated and released.

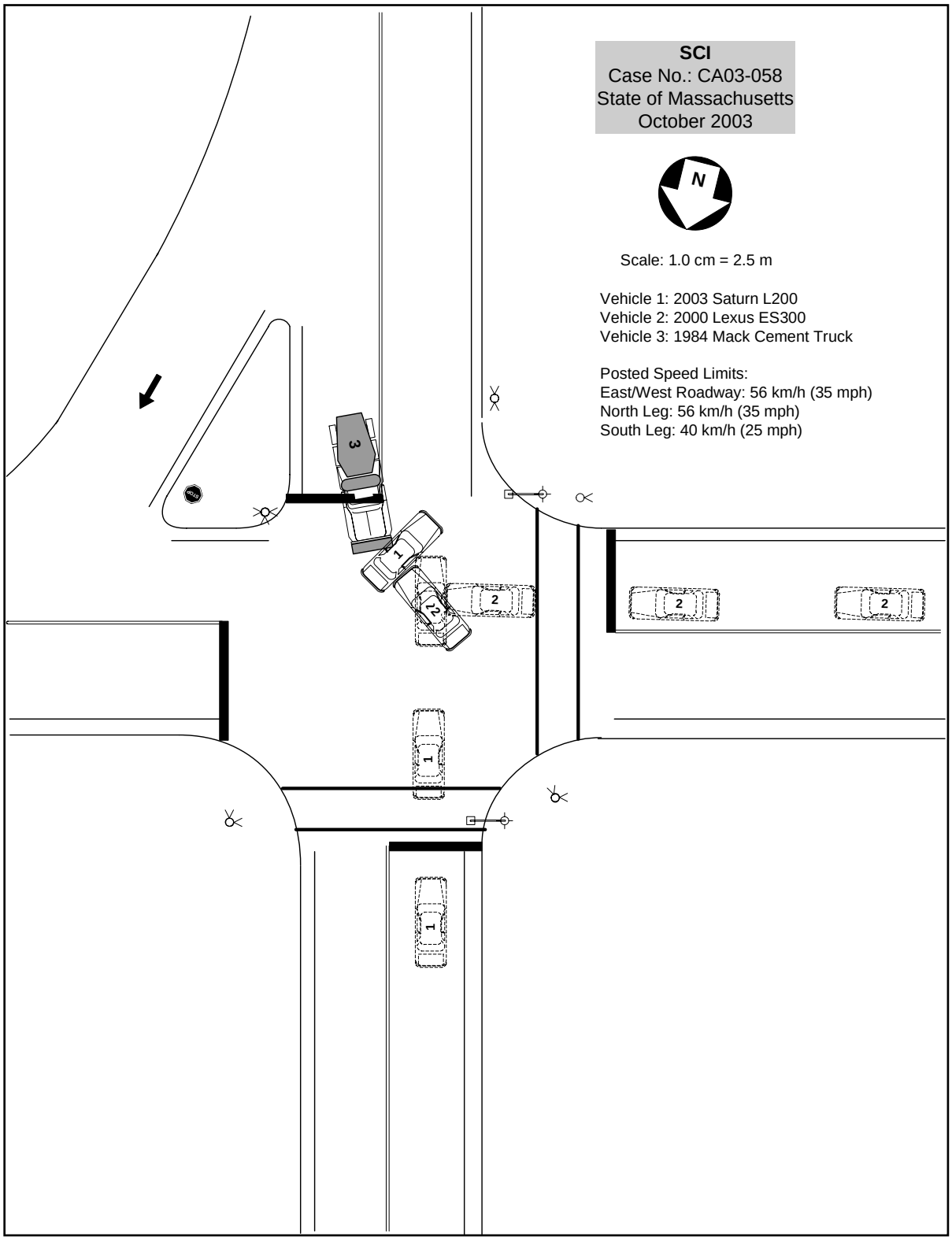


Figure 19. Scene schematic

ATTACHMENT A – EDR SUMMARY

CDR File Information

Vehicle Identification Number	1G8JU54F33Yxxxxxx
Investigator	
Case Number	CA03-058
Investigation Date	Tuesday, October 21 2003
Crash Date	Thursday, October 16 2003
Filename	CA03-058 NOSEQ.CDR
Saved on	Tuesday, October 21 2003 at 06:14:42 PM
Data check information	F1746BCC
Collected with CDR version	Crash Data Retrieval Tool 2.16
Collecting program verification number	BF3C7735
Reported with CDR version	Crash Data Retrieval Tool 2.24
Reporting program verification number	70CD83DD
Interface used to collected data	Block number: 00 Interface version: 35 Date: 01-02-03 Checksum: 6200
Event(s) recovered	Deployment Non-Deployment

SDM Data Limitations

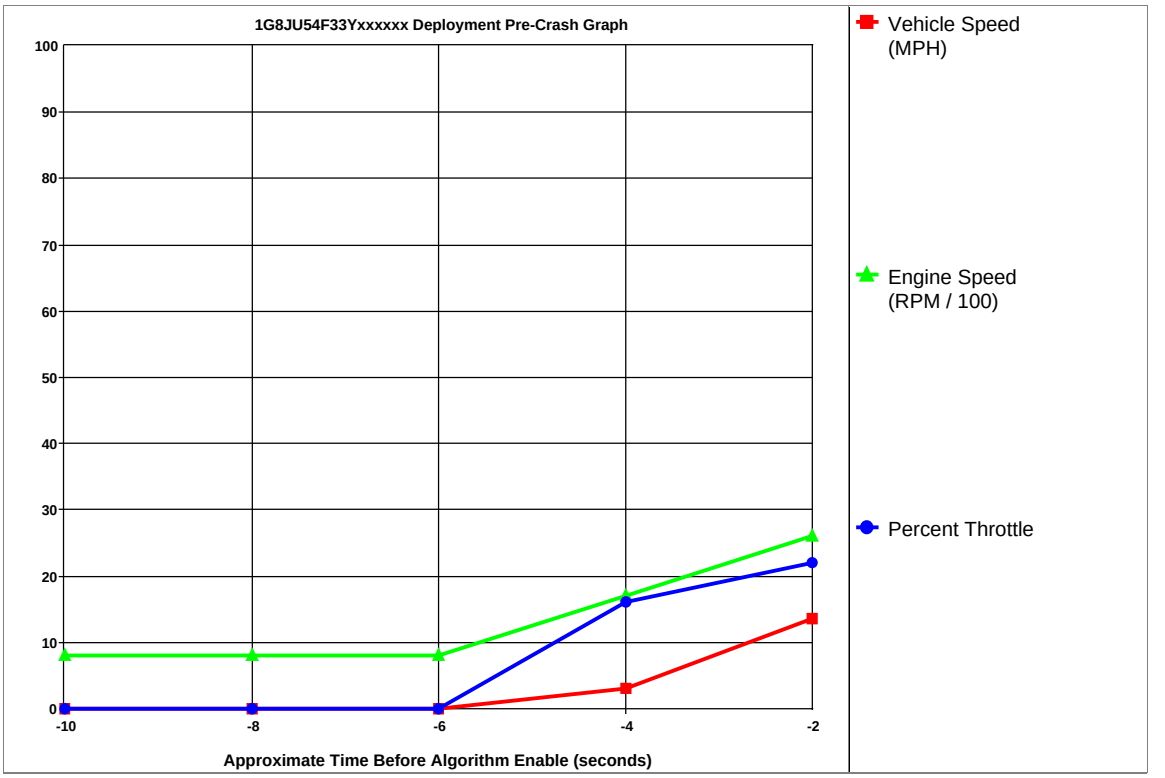
SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle forward velocity change.
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.
Deployment events can not be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the non-deployment file will be locked after a deployment.

SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change is one of the measures used to make air bag deployment decisions. SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward 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. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. The SDM records the first 150 milliseconds of Vehicle Forward Velocity Change after Algorithm Enable.
-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.
-SDM Recorded Vehicle Speed accuracy can be affected if the vehicle has had the tire size or the final drive axle ratio changed from the factory build specifications.
-Brake Switch Circuit Status indicates the status of the brake switch circuit.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if the SDM does not receive a valid message.
-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 and Time between Deployment and Deployment Level 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.

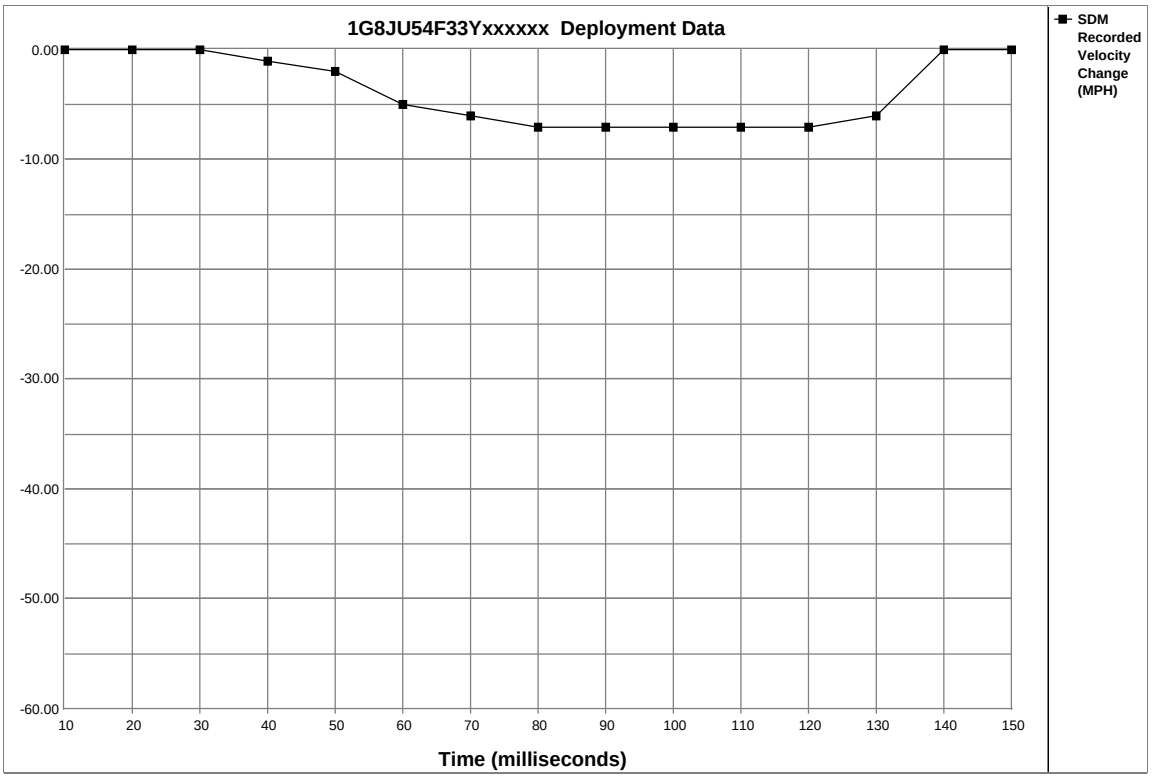
SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, Percent Throttle, and Brake Switch Circuit Status data are transmitted once every 2 second by the Powertrain Control Module (PCM), via the Class 2 data link, to the SDM.
-The Driver's Belt Switch Circuit is wired directly to the SDM.

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	2380
Time From Algorithm Enable to Deployment Command Criteria Met (msec)	46
Time Between Non-Deployment And Deployment Events (sec)	N/A
Time Between Deployment And Deployment Level Events (sec)	N/A
Brake Switch State at Algorithm Enable	Not Applied
Brake Switch State Validity Status	Valid
Event Recording Complete	Yes



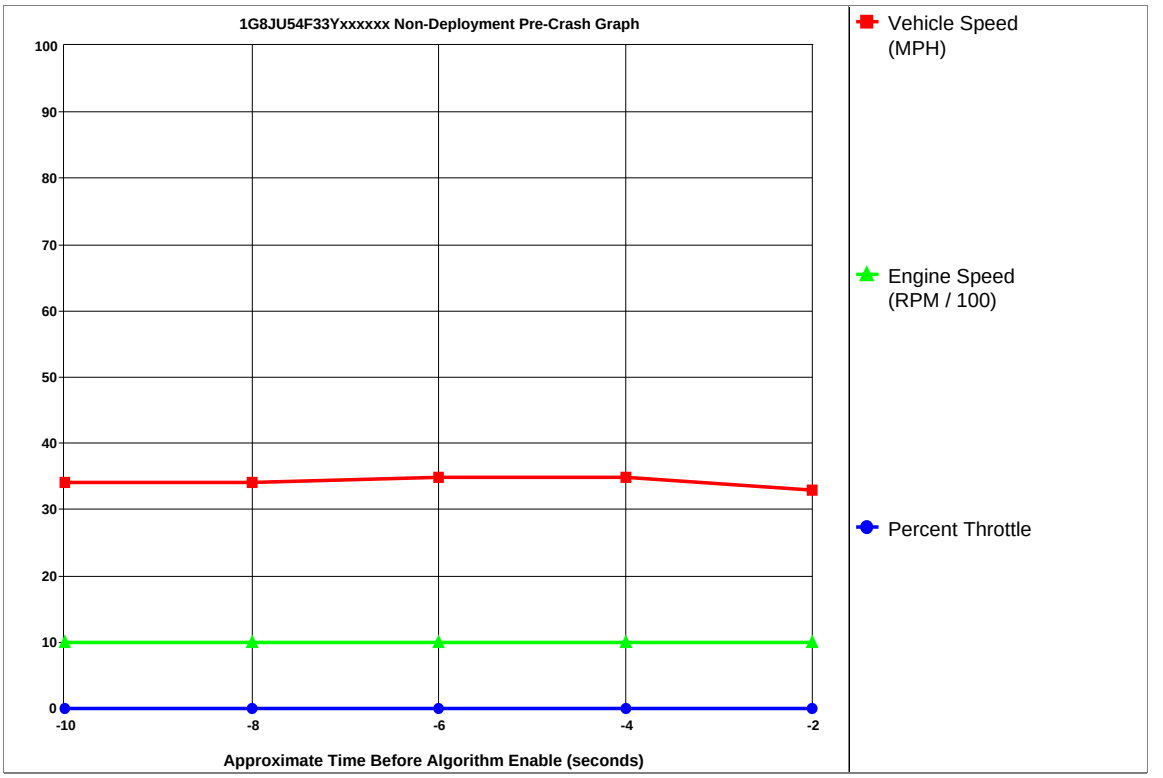
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-10	0	768	0
-8	0	768	0
-6	0	768	0
-4	3	1728	16
-2	14	2624	22



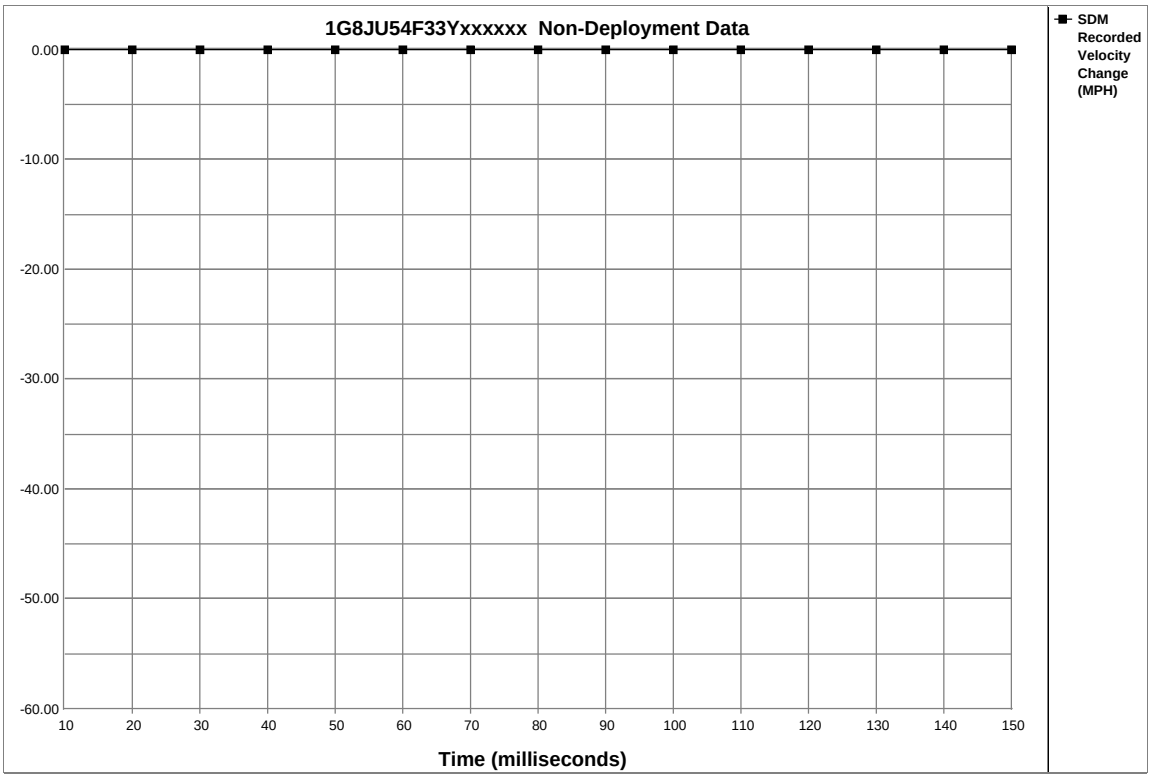
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	0.00	0.00	0.00	-1.00	-2.00	-5.00	-6.00	-7.00	-7.00	-7.00	-7.00	-7.00	-6.00	0.00	0.00

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	2184
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	10
Brake Switch State at Algorithm Enable	Applied
Brake Switch State Validity Status	Valid
Event Recording Complete	Yes



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-10	34	1024	0
-8	34	960	0
-6	35	1024	0
-4	35	1024	0
-2	33	960	0



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	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Hexadecimal Data

This page displays all the data retrieved from the air bag module.
It contains data that is not converted by this program.

```
$01  0B 14 2E 2E FF FF
$02  00 07 00 00 00 00
$03  41 53 32 32 39 35
$04  30 35 30 30 30 4A
$05  30 30 4B 30 4B 48
$06  22 66 04 87 00 00
$11  67 FF 00 FF 00 04
$12  00 00 00 00 00 00
$13  0E 00 00 00 00 00
$14  8F 03 5A FF 00 00
$18  66 66 67 7F 7E 80
$1C  38 34 4A FA FA FA
$1D  FA 38 34 4A FA FA
$1E  FA FA 00 00 00 00
$1F  FF 00 00 00 00 00
$20  00 00 04 00 00 00
$21  FF FF FF FF FF FF
$22  FF FF 0A 0E 00 00
$23  00 00 00 00 00 00
$24  00 00 00 00 00 00
$25  00 35 38 38 37 37
$26  01 00 00 00 00 00
$27  0F 10 10 0F 10 00
$28  00 00 00 08 88 00
$29  07 00 FD FF FF 00
$2A  FF FF FF A5 00 00
$2B  00 00 00 00 00 00
$30  00 00 0C 00 00 00
$31  FF FF FF FF FF FF
$32  FF FF 2E 00 0A 00
$33  00 00 01 02 05 06
$34  07 07 07 07 07 06
$35  00 00 16 05 00 00
$36  00 00 37 29 00 00
$37  00 29 1B 0C 0C 0C
$38  00 00 00 00 09 4C
$39  00 A7 A7 FF A5 00
$3A  00 00 00 00 00 00
$3B  00 00 00 00 00 00
$40  00 00 0C 00 00 00
$41  FF FF FF FF FF FF
$42  FF FF A5 00 00 00
```