TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

General Dynamics
Buffalo, NY 14225

GENERAL DYNAMICS ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION SCI TECHNICAL SUMMARY REPORT

CASE NO. CA03-043

VEHICLE – 2003 CADILLAC ESCALADE EXT

LOCATION - STATE OF MICHIGAN

CRASH DATE – JULY 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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

DISCLAIMER

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 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. CA03-043	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle General Dynamics On-Site Certified Advanced 208-Compliant Vehicle Crash Investigation Vehicle: 2003 Cadillac Escalade EXT Location: State of Michigan		*5. Report Date*: December 2004 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Transportation Sciences Crash Data Research Center General Dynamics P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0142 *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: July 2003 *14. Sponsoring Agency Code*	
15. Supplementary Note On-site investigation of a Certified Advanced 208-Compliant safety system in a 2003 Cadillac Escalade that was involved in an angular left side crash sufficient to deploy the frontal and left side air bags, and a subsequent tripped rollover.			
16. Abstract This on-site investigative effort focused on the crash severity and the performance of the Advanced 208-Compliant frontal air bag system in a 2003 Cadillac Escalade EXT sport utility vehicle. The manufacturer of this vehicle has certified that this 2003 Escalade EXT meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Cadillac Escalade was equipped with dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant presence system, and an Event Data Recorder (EDR). In addition, the Escalade was equipped with seat-mounted side impact air bags. The Escalade was occupied by a 57-year-old male driver and a 56-year-old female front right passenger. Both occupants were restrained by the manual 3-point lap and shoulder belt system. The Escalade was traveling on the inboard lane of a four-lane divided roadway during daylight hours. The driver of a 1990 Pontiac Grand Prix was traveling in the opposite direction and lost directional control of the vehicle. The Pontiac traversed the median in a tracking mode and struck the left side aspect of the Escalade. The impact resulted in a dual-stage frontal air bag deployment and the deployment of the driver's side impact air bag. The impact induced a counterclockwise (CCW) rotation of the Escalade, however, the driver overcorrected with a right steer input, which reversed the rotation and induced a clockwise (CW) yaw. The resistance of the debeaded left rear tire and damaged wheel of the Escalade's against the asphalt roadway induced a tripped rollover onto its left side. The vehicle slid along the travel lanes to final rest on it left side. Following the initial impact, the Grand Prix was struck by a tractor-trailer combination. The driver of the Escalade did not sustain injury. The front right passenger sustained a left abdomen contusion as a result of loading against the center armrest/console, a left arm abrasion from probable contact with the deployed front right passenger's air bag, and knee and lower leg contusions and abrasions. The front right passenger was transported by ambulance to a local hospital and was treated and released. The driver accompanied the front right passenger to the hospital in the ambulance, but did not receive any medical treatment.			
17. Key Words Frontal air bag deployment Occupant sensing Side air bag deployment Event Data Recorder		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 20	*22. Price*

TABLE OF CONTENTS

BACKGROUND **1**

VEHICLE DATA – 2003 CADILLAC ESCALADE **2**

VEHICLE DATA – 1990 PONTIAC GRAND PRIX **3**

VEHICLE DATA – 1998 FREIGHTLINER TRACTOR SEMI-TRAILER **3**

CRASH SITE **3**

CRASH SEQUENCE **3**

PRE-CRASH 3
CRASH 4
POST-CRASH 4

VEHICLE DAMAGE **5**

EXTERIOR DAMAGE – 2003 CADILLAC ESCALADE EXT 5
INTERIOR DAMAGE – 2003 CADILLAC ESCALADE EXT 6

MANUAL RESTRAINT SYSTEMS – 2003 CADILLAC ESCALADE **7**

CERFITIED ADVANCED 208-COMPLIANT SAFETY SYSTEM – 2003 CADILLAC ESCALADE **8**

SIDE IMPACT AIR BAG SYSTEM **9**

OCCUPANT DEMOGRAPHICS – 2003 CADILLAC ESCALADE **9**

DRIVER 9
DRIVER KINEMATICS 9
FRONT RIGHT PASSENGER 10
FRONT RIGHT PASSENGER INJURIES 10
FRONT RIGHT PASSENGER KINEMATICS 10

FIGURE 15. SCENE SCHEMATIC **12**

APPENDIX A – EDR OUTPUT FROM 2003 CADILLAC ESCALADE **13**

GENERAL DYNAMICS ON-SITE ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION
SCI TECHNICAL SUMMARY REPORT
CASE NO. – CA03-043
SUBJECT VEHICLE – 2003 CADILLAC ESCALADE EXT
LOCATION - STATE OF MICHIGAN
CRASH DATE – JULY 2003

BACKGROUND

This on-site investigative effort focused on the crash severity and the performance of the Advanced 208-Compliant frontal air bag system in a 2003 Cadillac Escalade EXT sport utility vehicle. The manufacturer of this vehicle has certified that this 2003 Escalade EXT meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Cadillac Escalade **(Figure 1)** was equipped with dual stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant presence system, and an Event Data Recorder (EDR). In addition, the Escalade was equipped with seat-mounted side impact air bags.

Figure 1. Damaged 2003 Cadillac Escalade EXT

The Escalade was occupied by a 57-year-old male driver and a 56-year-old female front right passenger. Both occupants were restrained by the manual 3-point lap and shoulder belt system. The Escalade was traveling on the inboard lane of a four-lane divided roadway during daylight hours. The driver of a 1990 Pontiac Grand Prix was traveling in the opposite direction and lost directional control of the vehicle. The Pontiac traversed the median in a tracking mode and struck the left side aspect of the Escalade. The impact resulted in a dual-stage frontal air bag deployment and the deployment of the driver's side impact air bag. The impact induced a counterclockwise (CCW) rotation of the Escalade, however, the driver overcorrected with a right steer input, which reversed the rotation and induced a clockwise (CW) yaw. The resistance of the debeaded left rear tire and damaged wheel of the Escalade's against the asphalt roadway induced a tripped rollover onto its left side. The vehicle slid along the travel lanes to final rest on its left side. Following the initial impact, the Grand Prix was struck by a tractor-trailer combination. The driver of the Escalade did not sustain injury. The front right passenger sustained a left abdomen contusion as a result of loading against the center armrest/console, a left arm abrasion from probable contact with the deployed front right passenger's air bag, and knee and lower leg contusions and abrasions. The front right passenger was transported by ambulance to a local hospital and was treated and released. The driver accompanied the front right passenger to the hospital in the ambulance, but did not receive any medical treatment.

This crash was identified by NASS PSU 11 during routine sampling activities. The Police Accident Report (PAR) was forwarded to the NASS Zone Center and forwarded to the SCI team as a possible Advanced 208-Compliant crash investigation. The case was assigned by the Crash Investigation Division (CID) of NHTSA as an on-site investigation on August 6, 2003. The SCI

team located the Cadillac Escalade at a salvage facility for this July crash. At the time of the case assignment, the Grand Prix had been sold and scrapped.

VEHICLE DATA – 2003 Cadillac Escalade

The 2003 Cadillac Escalade was identified by the Vehicle Identification Number (VIN): 3GYEK63N73G (production sequence omitted). The driver estimated that the odometer read approximately 14,484 km (9,000 miles). The vehicle was a four-door sport-utility-vehicle configured with a 6.0-liter H.O. Vortec 6000 V8 345 horsepower engine, an all-wheel-drive system with Stabilitrak, traction control, torque transfer between front and rear axles, and a heavy-duty Hydra-Matic four-speed automatic transmission with overdrive fourth gear and tow/haul mode. The Escalade EXT was also equipped with a fully automatic rear-leveling system, road-sensing suspension, four-wheel disc brakes with ABS, power steering, a tilt steering wheel, and adjustable pedals that were in the mid-position. The Escalade EXT was configured with a removable Midgate panel that separated the rear seat from the cargo bed. Removal of the Midgate reconfigured the cargo bed length from 1.5 m (5.0') to 2.4 m (8.0'). The rear window was removable and could be stowed in a specially designed pocket on the interior aspect of the Midgate panel. The Cargo bed was also configured with three lightweight, rigid, removable, composite tonneau covers that were secured in longitudinally oriented tracks on the upper outboard aspects of the cargo bed walls.

The Escalade EXT was configured with Goodyear Wrangler HP P265/70R17 tires. The manufacturer's recommended tire pressure for each tire was 210 kpa (30 psi). The specific tire data is as follows:

Tire	Measured Pressure	Maximum Pressure	Tread Depth	Restricted	Damage
LF	275.8 kpa (40.0 psi)	303.4 kpa (44.0 psi)	9 mm (11/32")	No	None
LR	0.0 kpa	303.4 kpa (44.0 psi)	9 mm (11/32")	Yes	Cuts in the sidewall
RF	251.7 kpa (36.5 psi)	303.4 kpa (44.0 psi)	9 mm (11/32")	No	None
RR	0.0 kpa	303.4 kpa (44.0 psi)	9 mm (11/32")	Yes	None

The Escalade EXT was configured with front bucket seats with leather seating surfaces, independent heated seat backs and seat cushions with three temperature settings, and adjustable head restraints. The driver's seat was positioned at the full-rear track position and the front right passenger's seat was positioned 3.8 cm (1.5") forward of full rear and 19.1 cm (7.5") rear of full forward track position. The three second row seating positions were configured with a 60/40 split bench seat with leather seating surfaces, a folding center armrest, and heated outboard seat cushions with two temperature settings. The rear bench seat cushions folded forward to accommodate the forward folding rear seat backs.

VEHICLE DATA – 1990 Pontiac Grand Prix

The 1990 Pontiac Grand Prix was identified by the VIN that was reported on the PAR: 1G5WP14VOLF (production sequence omitted). At the time of the on-site investigation, the Grand Prix had been sold and scrapped. Based on the VIN, the Grand Prix was a two-door coupe that was equipped with a 3.1 liter, V6 engine, power steering, anti-lock brakes, and automatic safety belts for the front seat positions.

VEHICLE DATA – 1998 Freightliner Tractor Semi-Trailer

The 1998 Freightliner power unit was identified by the VIN that was reported on the PAR: 1FUY3MD82WL (production sequence omitted). The power unit was a model FLD-112 Medium Conventional Aluminum non-sleeper chassis cab 6 x 4 truck tractor with air brakes. The type of trailer was not reported, and it was not known if the truck was carrying cargo at the time of the crash. The tractor semi-trailer was driven from the scene, and was not available for inspection.

CRASH SITE

This three-vehicle crash occurred during the daylight hours of July 2003 in the state of Michigan. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The crash occurred on the southbound lanes of a four-lane divided roadway. The roadway was straight and level at the crash site. It was configured with two travel lanes in each direction that were separated by a grassy median that measured 18.4 m (60.4') in width. The southbound travel lanes were separated by a broken white centerline and bordered on the inboard aspect by a solid yellow fog line and on the outboard aspect by a solid white fog line. The travel lanes were bordered by asphalt shoulders that measured 1.4 m (4.6') and 3.4 m (11.2') on the inboard and outboard aspects, respectively. The posted speed limit for the north/south roadway was 113 km/h (70 mph). The scene schematic is included as **Figure 15** of this report.

Figure 2. Southbound approach for the Escalade

CRASH SEQUENCE

Pre-Crash

The 57-year-old male driver was operating the Escalade on the southbound inboard lane of the four-lane roadway **(Figure 2)**. The EDR summary indicated that the Escalade's travel speed was 126 km/h (78 mph) five seconds prior to the deployment event and 129 km/h (80 mph) one second prior to the deployment event. The 42-year-old female driver of the Pontiac Grand Prix was traveling in the northbound lanes. Her pre-crash travel speed was unknown. The driver of the Grand Prix detected stopped traffic in the northbound lanes, steered left, and lost control of the vehicle. The Grand Prix departed the northbound lanes **(Figure 3)**

Figure 3. Northbound approach across the median for the Grand Prix

and traversed the grassy median in a tracking mode toward the southbound travel lanes. It was not known if the driver attempted to apply the brakes. The driver of the Escalade stated that he observed the Grand Prix traverse the median and estimated that the Grand Prix would enter the southbound lanes behind the Escalade. Based on the EDR output showing throttle percentage, the driver accelerated slightly and removed his foot from the accelerator one second prior to the impact.

Crash

The Grand Prix continued onto the southbound travel lanes. The front aspect of the Grand Prix impacted the left passenger area of the Escalade. The direction of force was in the 12 o'clock sector for the Escalade and in the 1 o'clock sector for the Grand Prix. The output from the Escalade's EDR stated that the maximum delta-V for the Escalade was 15.18 km/h (9.43 mph). According to the EDR summary, the time from algorithm enable to maximum recorded velocity change was 110 milliseconds, and the impact was sufficient to deploy the first and second stages of the frontal air bag system and the driver's side impact air bag. The EDR report is included at the end of this report. The forward momentum of the Escalade resulted in the snagging of the left B-pillar and left rear axle on the bumper of the Grand Prix as it penetrated the left side plane of the Escalade. The Grand Prix rotated in a CCW direction in the inboard southbound lane as the Escalade initiated a CCW yaw. The driver of the Escalade steered right in an attempt to regain control of the vehicle. He overcorrected which initiated in a CW yaw. The damage and displacement of the Escalade's rear axle and tire air-out contributed to the CW yaw as the vehicle continued along the southbound travel lanes. The resistance of the Escalade's debeaded left rear tire and damaged alloy wheel against the asphalt roadway caused the Escalade to trip-over onto the left side plane which resulted in a near-deployment event that was recorded three seconds after the deployment event. The Escalade slid a short distance on its left side and came to rest in the center of the southbound travel lanes on its left side. A tractor semi-trailer was traveling in the outboard southbound lane and struck the Grand Prix with the front left aspect. It was not known if the Grand Prix had stabilized prior to the impact with the truck. The secondary impact deflected the Grand Prix in a rapid CCW rotation as the truck continued in a forward direction. The Grand Prix came to rest in the center aspect of the southbound lanes near the initial point of impact. The driver of the tractor semi-trailer brought the vehicle to a controlled stop on the outboard shoulder after the impact with the Grand Prix.

Post-Crash

The Escalade came to rest in the center of the southbound lanes on its left side. The driver stated that he unbuckled his safety belt, as well as the safety belt of the front right passenger. The front right passenger was assisted out of the right front door by passers-by and the driver exited the vehicle through the right front door under his own power. The front right passenger was transported by ambulance to a local hospital and was treated and released. The driver accompanied the front right passenger to the hospital in the ambulance, but did not receive any medical treatment. All of the vehicles were towed from the scene. A small 7 kg (15 lb) dog was lying on the rear floor area, and was uninjured in the crash.

VEHICLE DAMAGE

Exterior Damage – 2003 Cadillac Escalade EXT

Figure 4. View of left side damage to the Escalade

The 2003 Cadillac Escalade sustained moderate left side damage **(Figure 4)** as a result of the initial impact with the Grand Prix. The direct damage began 7.0 cm (2.8”) aft of the left front axle and extended rearward 426.0 cm (167.7”) along the left side plane. Heavy red paint transfers were present along the entire direct damage length. The transfers began at the bottom aspects of the left side doors and extended 55.9 cm (22.0”) vertically. The left front and left rear doors sustained lateral crush and rearward displacement due to the forward momentum of the Escalade and snagging of the Grand Prix. The maximum lateral crush was located 217.0 cm (85.4”) aft of the front left axle and measured 27.9 cm (11.0”) at mid-door. The base of the left B-pillar was separated and displaced 40.0 cm (16.1”) rearward **(Figure 5)**. The rear aspect of the left rear door overlapped the left C-pillar 17.8 cm (7.0”). The longitudinal separation between the rear aspect of the left front door and the front aspect of the left rear door measured 34.9 cm (13.8”). The left rear axle was rotated CCW as a result of the direct contact with the Grand Prix. The left rear aspect of the axle was displaced 13.0 cm (5.1”) rearward and separated from the left rear control arm. The left rear tire exhibited a tear on the outboard sidewall and was debeaded and restricted against the rear aspect of the left rear quarter panel. The combined direct and induced damage from the initial impact with the Grand Prix measured 426.0 cm (167.7”). The CCW rotation of the rear axle resulted in the reduction of the right side wheelbase by 5.0 cm (2.0”). Although the sideswipe configuration was outside the scope of WinSMASH, six crush measurements were documented along the left side mid-door aspect of the Escalade and were as follows: C1 = 0.0 cm, C2 = 18.4 cm (7.3”), C3 = 25.4 cm (10.0”), C4 = 15.2 cm (6.0”), C5 = 6.6 cm (2.6”), C6 = 5.1 cm (2.0”). The Collision Deformation Classification (CDC) for the impact with the Grand Prix was 12-LDES-2.

Figure 5. Close-up of separated left B-pillar

Figure 6. Close-up of abrasions on the front left aspect from the rollover event

The Escalade sustained moderate left side damage as a result of the trip-over. Lateral abrasions were present on the left front fender, left A-pillar, left roof side rail, left front door, left rear door, and left rear quarter panel from contact with the asphalt roadway surface **(Figure 6)**. The direct

contact damage began 63.0 cm (24.8”) forward of the left front axle and measured 523.0 cm (205.9”) rearward. The combined direct and induced damage from the trip-over event involved the entire left side plane of the Escalade. The CDC for the trip-over event was 00-LDAO-2.

Interior Damage – 2003 Cadillac Escalade EXT

The Escalade sustained moderate interior damage as a result of passenger compartment intrusion and occupant contact (**Figure 7**). The interior left front door panel was deformed and partially separated. Two minor scuff marks were present on the knee bolster 7.0 cm (2.8”) left of the steering column. The left B-pillar was intruded laterally and rearward, and was engaged against the outboard aspect of the driver’s seat back **(Figure 8)**. A scuff mark was present on the right forward aspect of the center console 25.4 cm (10.0”) above the floor from contact with the front right passenger’s left leg. The left rear seat cushion was deformed laterally due to the passenger compartment intrusion and the center rear seat cushion was deformed laterally and downward against the rear right seat cushion. The vertical displacement of the center cushion measured 5.1 cm (2.0”).

Figure 7. Left side view of intrusions and occupant contacts

Figure 8. Left side view showing B-pillar intrusion

The right rear seat cushion latch located at the rear aspect of the cushion was deformed to the left, and the respective anchor was deformed 6.4 cm (2.5”) to the right, as a result of the left and center seat cushion lateral displacement. Refer to **Figures 9 and 10**.

Figure 9. Overall view of rear right seat cushion

Figure 10. Close-ups of deformed anchor and latch

Multiple passenger compartment intrusions were documented as follows:

Position	Intruded Component	Magnitude of Intrusion	Direction
Front left	Roof side rail	8.9 cm (3.5”)	Vertical
Front left	Roof side rail	3.8 cm (1.5”)	Lateral
Front left	Left front door	3.8 cm (1.5”)	Lateral
Second row left	Left B-pillar	40.0 cm (16.1”)	Longitudinal
Second row left	Left B-pillar	15.2 cm (6.0”)	Lateral
Second row left	Left C-pillar	6.4 cm (2.5”)	Lateral
Second row left	Left rear door	25.4 cm (10.0”)	Lateral

MANUAL RESTRAINT SYSTEMS – 2003 Cadillac Escalade

The 2003 Cadillac Escalade EXT was equipped with integrated 3-point lap and shoulder belts for the front seat positions. There was no height adjustment present for the integrated restraints. The driver’s safety belt was configured with an Emergency Locking Retractor (ELR) and a sliding latch plate. The driver’s safety belt webbing had been cut post-crash and used to secure the left front door to the vehicle. The segment of webbing measured 103.5 cm (40.8”) in length. The plastic cover on the driver’s seat back-mounted shoulder belt guide exhibited minor abrasions from engagement with the shoulder belt webbing as a result of driver loading. The front right passenger’s safety belt **(Figure 11)** was configured with a switchable ELR/Automatic Locking Retractor (ALR) and a sliding latch plate. Minor stretching of the webbing measured 24.8 cm (9.8”) in length and was located 63.5 cm (25.0”) above the anchor. The plastic cover on the front right passenger’s shoulder belt guide was abraded from engagement with the shoulder belt webbing from occupant loading.

Figure 11. View of front right passenger's safety belt

The Escalade was equipped with manual 3-point lap and shoulder belts with sliding latch plates and switchable retractors for each rear seating position. The rear left safety belt was restricted in the stowed position as a result of passenger compartment intrusion.

CERFITIED ADVANCED 208-COMPLIANT SAFETY SYSTEM – 2003 Cadillac Escalade

The Cadillac Escalade was equipped with a Certified Advanced 208-Compliant Safety System that included dual-stage frontal air bags, seat track position sensors, a front right occupant presence system, and an EDR. The manufacturer of this vehicle has certified that this 2003 Escalade meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

The driver's air bag (**Figure 12**) deployed as a result of the rapid longitudinal deceleration of the Escalade during the initial impact with the Grand Prix. The driver's air bag deployed from the steering wheel hub through symmetrical I-configuration cover flaps. Each flap measured 12.1 cm (4.8") in height and 6.4 cm (2.5") in width. The deployed air bag measured 66.0 cm (26.0") in diameter. The air bag was vented by two circular ports located at the 11 and 1 o'clock positions on the rear aspect of the air bag. The vent ports measured 2.5 cm (1.0") in diameter and were located 8.9 cm (3.5") inboard of the circumferential seam. The air bag was tethered by two internal straps located at the 3 and 9 o'clock positions that measured 12.7 cm (5.0") in width. A minor body fluid transfer that measured 2.5 cm (1.0") in length was located 11.4 cm (4.5") right of the vertical centerline and 24.1 cm (9.5") above the horizontal centerline. Small body fluid transfers were present on the rear right aspect of the air bag from post-crash handling by the occupant.

Figure 12. Deployed driver's air bag

The front right passenger's air bag **(Figure 13)** deployed from a mid-mount module configured with a rectangular cover flap hinged at the forward aspect. The cover flap measured 38.7 cm (15.3") in width and 14.0 cm (5.5") in height. The deployed air bag measured 50.8 cm (20.0") in width and 61.0 cm (24.0") in height. The air bag was vented by two circular ports located at the 3 and 9 o'clock positions on the side panels of the air bag. The vent ports measured 2.4 cm (1.0") in diameter and were located 10.2 cm (4.0") below the top of the air bag and 10.2 cm (4.0") rear of the face of the air bag. The air bag was configured with a full-width tether vertically centered in the air bag. There was no occupant contact evidence on the air bag or cover flap. Dirt and vehicle fluid transfers were present on the face of the air bag.

Figure 13. Deployed front right passenger's air bag

The Advanced 208-compliant safety system was configured with a weight sensor in the front right seat cushion designed to detect occupant presence and automatically suppress the front right passenger's air bag if the measured occupant weight was below a designed threshold. The air bag on/off status could be confirmed by a light on the rearview mirror. The front right seat

position was also equipped with a seat track position sensor, which adjusted the air bag deployment level if the seat was in a forward track position.

SIDE IMPACT AIR BAG SYSTEM

The Escalade was configured with seat back-mounted side impact air bags for the driver and front right passenger positions. Each side impact air bag was configured with a vinyl module cover flap that measured 5.1 cm (2.0") in width and 15.9 cm (6.3") in height and was hinged at the rear aspect. The driver's side impact air bag **(Figure 14)** deployed as a result of the initial left side contact with the Grand Prix. The driver's air bag deployed forward from the driver's seat back-mounted module. The air bag measured 40.6 cm (16.0") in length and 22.9 cm (9.0") in height, and provided only torso protection. The side impact air bag forward excursion measured 24.1 cm (9.5") forward of the front aspect of the driver's seat back. There was no occupant contact evidence present on the driver's side impact air bag.

Figure 14. Deployed driver's side impact air bag

OCCUPANT DEMOGRAPHICS – 2003 Cadillac Escalade

Driver

Age/Sex:	57-year-old male driver
Height:	183 cm (72")
Weight:	81 kg (180 lb)
Seat Track Position:	Full-rear
Manual Restraint Use:	Integrated manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, interview
Eyewear:	None
Type of Medical Treatment:	Accompanied the front right passenger in the ambulance to a local hospital but did not receive medical treatment

Driver Kinematics

The 57-year-old driver of the Cadillac Escalade was seated in an upright posture and restrained by the integrated manual 3-point lap and shoulder belt. The driver stated that the seat track was adjusted to the full-rear position, which was confirmed by the vehicle inspection. He was unsure of the position of the adjustable pedals, and stated that the pedal adjustment feature was not used regularly. Based on the vehicle inspection, the adjustable pedals were adjusted to the mid-range position. At impact with the Grand Prix, the frontal air bag system deployed and the driver's side impact air bag deployed. The driver initiated a forward and slightly lateral trajectory to the left and loaded the safety belt and deployed driver's air bag. His left knee contacted the knee bolster, evidenced by a faint scuff mark on the knee bolster left of the steering column. As the direction of force was primarily longitudinal, only minor contact with the driver's side impact air bag occurred during the initial impact. The driver was redirected slightly to the right as the Escalade was deflected CCW. His right steer input and overcorrection resulted in a CW yaw, which redirected him to the left. He loaded the manual restraint, and the interior aspect of the left front

door as the Escalade rolled onto its left side. By the time the Escalade rolled onto its left side, the driver's side impact air bag had substantially deflated, and offered minimal protection against the lateral crash forces. The safety belt prevented additional movement throughout the vehicle and the driver came to rest in the driver's seat. The driver exited the vehicle under his own power through the right front door. He did not sustain injury but accompanied the front right passenger to a local hospital in the ambulance.

Front Right Passenger

Age/Sex:	56-year-old female
Height:	168 cm (66")
Weight:	68 kg (150 lb)
Seat Track Position:	3.8 cm (1.5") forward of full-rear and 19.1 cm (7.5") rear of full-forward
Manual Restraint Use:	Integrated manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, interview
Eyewear:	Prescription sunglasses
Type of Medical Treatment:	Transported by ambulance to a local hospital for treatment and released

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Right knee contusion	Minor (890402.1,1)	Possible contact with left knee or center console
Left knee contusion	Minor (890402.1,2)	Center console
Left knee abrasion	Minor (890202.1,2)	Center console
Right lower leg abrasion	Minor (890202.1,1)	Lower right instrument panel
Right lower arm abrasion (from wrist to elbow)	Minor (790202.1,1)	Front right passenger's air bag
Left abdominal contusion*	Minor (590402.1,2)	Center console/armrest

Injury source: Emergency room records, *Interview

Front Right Passenger Kinematics

The 56-year-old female front right passenger was seated in an upright posture and restrained by the integrated manual 3-point lap and shoulder belt. At impact, the frontal air bag system deployed and she initiated a forward and slightly lateral trajectory. She loaded the safety belt and the deployed front right passenger's air bag. She sustained a right lower arm abrasion that extended from the wrist to the elbow from contact with the deploying air bag. Her right lower leg sustained an abrasion, possibly a result of contact with the lower right instrument panel. She rebounded rearward and was redirected as the Escalade initiated the CCW rotation, and subsequent CW yaw. As the Escalade rolled onto its left side, she loaded the center console/armrest with her abdomen, which resulted in a self-reported left abdominal contusion. Her legs were displaced to the left, and she struck her left knee on the plastic center console, which resulted in a left knee abrasion and left knee contusion. The front right passenger also

sustained a right knee contusion, possibly from contact to the left leg/knee as she was displaced to the left. She came to rest with her upper body leaning over the center console area. The driver unbuckled her safety belt and she was assisted out of the right front door by passers-by. According to EMS records, she walked to the roadside and was found seated in a roadside ditch when rescue personnel arrived. She was transported by ambulance to a local hospital for treatment and released.

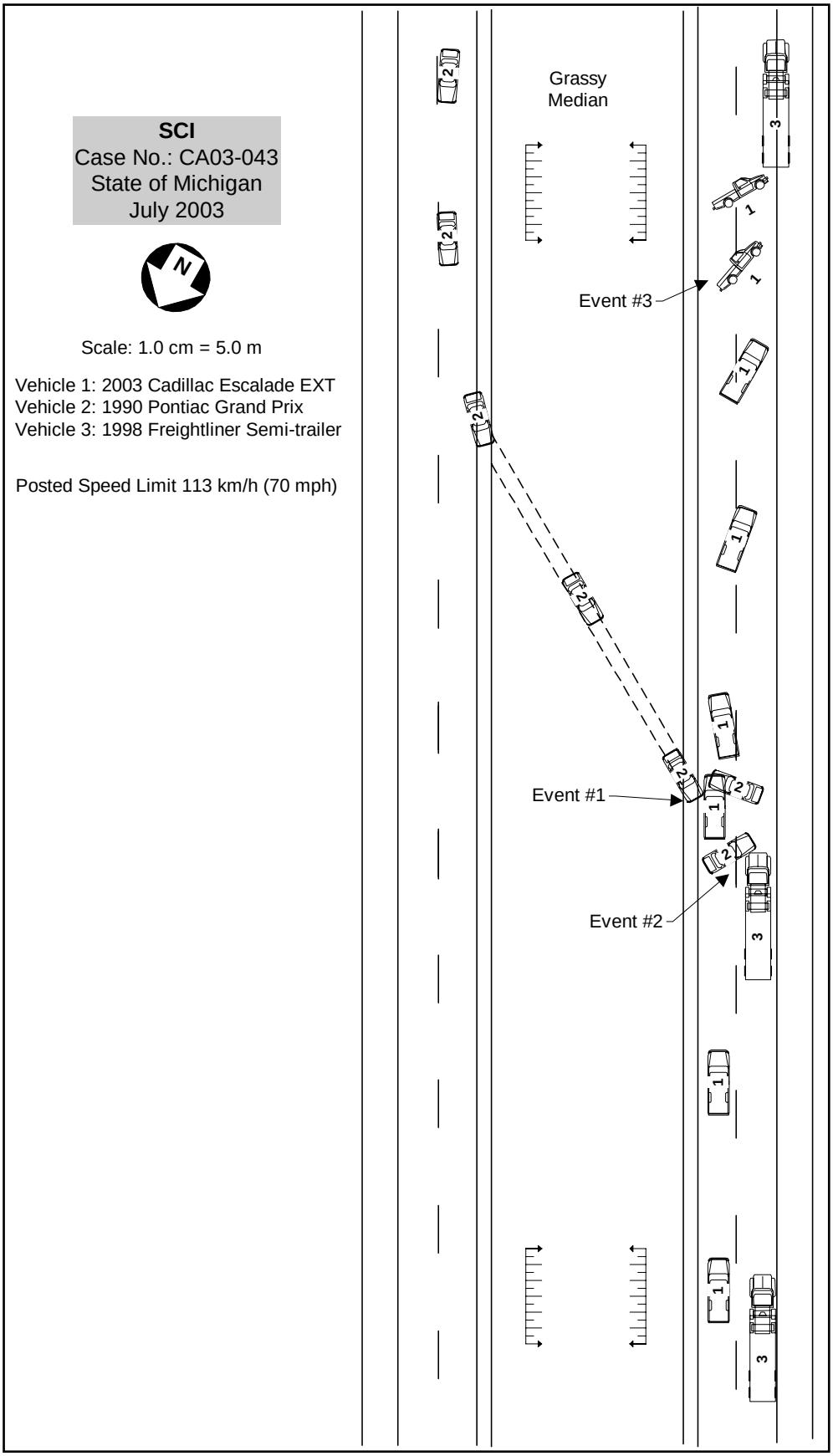


Figure 15. Scene schematic

APPENDIX A – EDR OUTPUT FROM 2003 CADILLAC ESCALADE

CDR File Information

Vehicle Identification Number	3GYEK63N73Gxxxxxx
Investigator	
Case Number	
Investigation Date	8/7/03
Crash Date	
Filename	
Saved on	
Data check information	1B9449CC
Collected with CDR version	Crash Data Retrieval Tool 2.00
Collecting program verification number	A31D1C76
Reported with CDR version	Crash Data Retrieval Tool 2.16
Reporting program verification number	BF3C7735 Block number: 00
Interface used to collected data	Interface version: 35 Date: 01-02-03 Checksum: 6200
Event(s) recovered	Deployment Non-Deployment

SDM Data Limitations

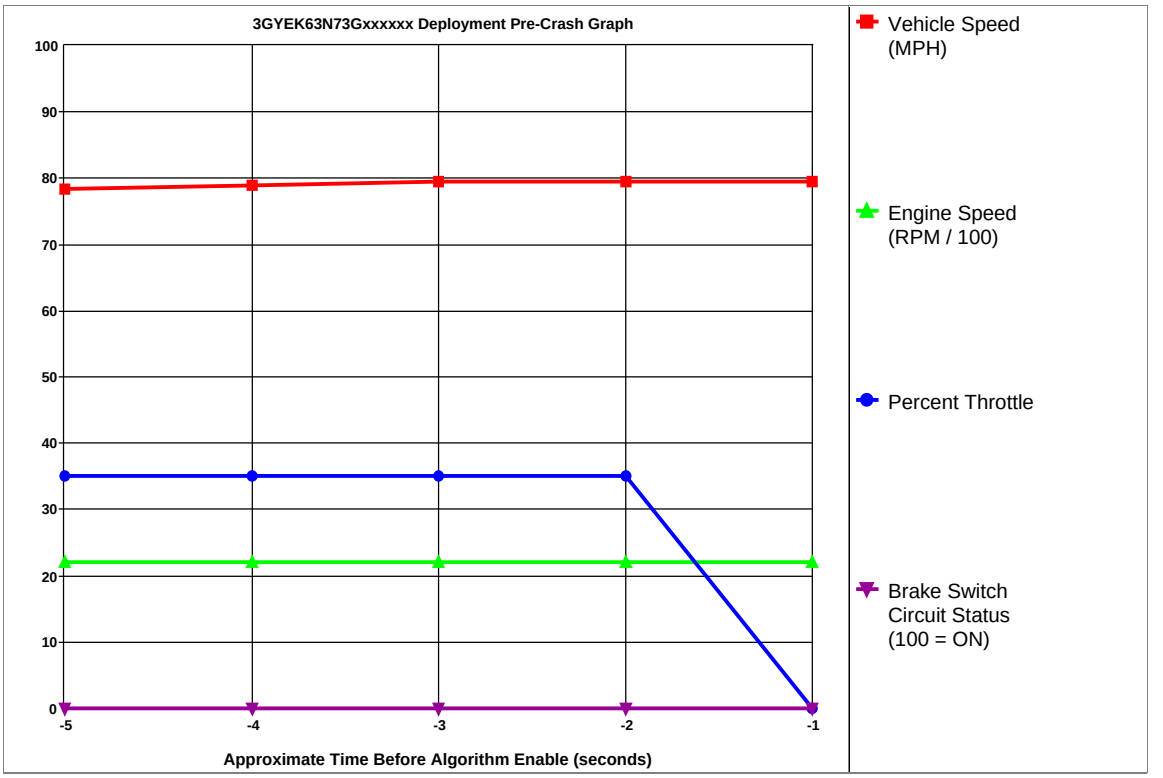
SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle forward velocity change. This event will be cleared by the SDM after the ignition has been cycled 250 times.
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, if the non-deployment occurred within 5 seconds before the deployment or a deployment level event occurs within 5 seconds after the 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. 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 will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. The SDM will also record 150 milliseconds of data after non-deployment criteria is met.
-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 is displayed in seconds. If the time between the two events is greater than 25.4 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.

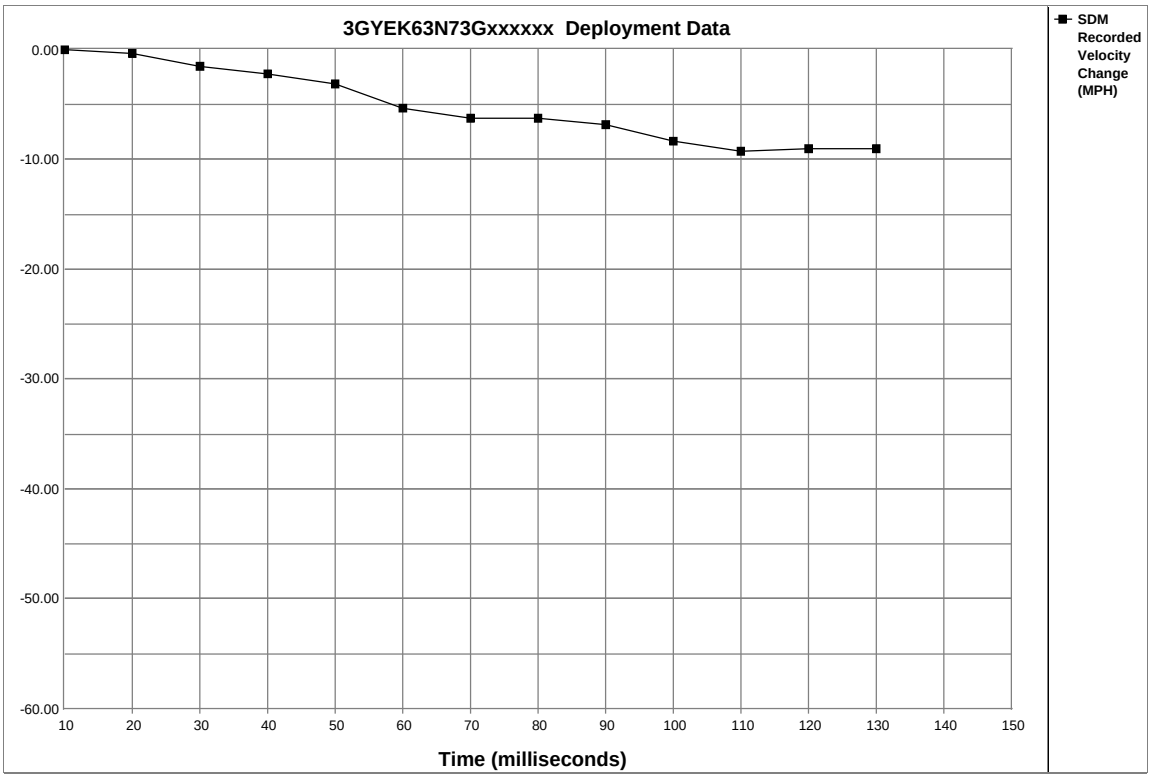
SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the Class 2 data link, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the Class 2 data link, to the SDM.
-In most vehicles, the Driver's Belt Switch Circuit is wired directly to the SDM. In some vehicles, the Driver's Belt Switch Circuit Status data is transmitted from the Body Control Module (BCM), via the Class 2 data link, to the SDM.

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	828
Ignition Cycles At Investigation	832
Maximum SDM Recorded Velocity Change (MPH)	-9.43
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	110
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	35
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	35
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	35
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	35
Time Between Non-Deployment And Deployment Events (sec)	N/A
Frontal Deployment Level Event Counter	1
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	78	2176	35	OFF
-4	79	2176	35	OFF
-3	80	2176	35	OFF
-2	80	2240	35	OFF
-1	80	2240	0	OFF

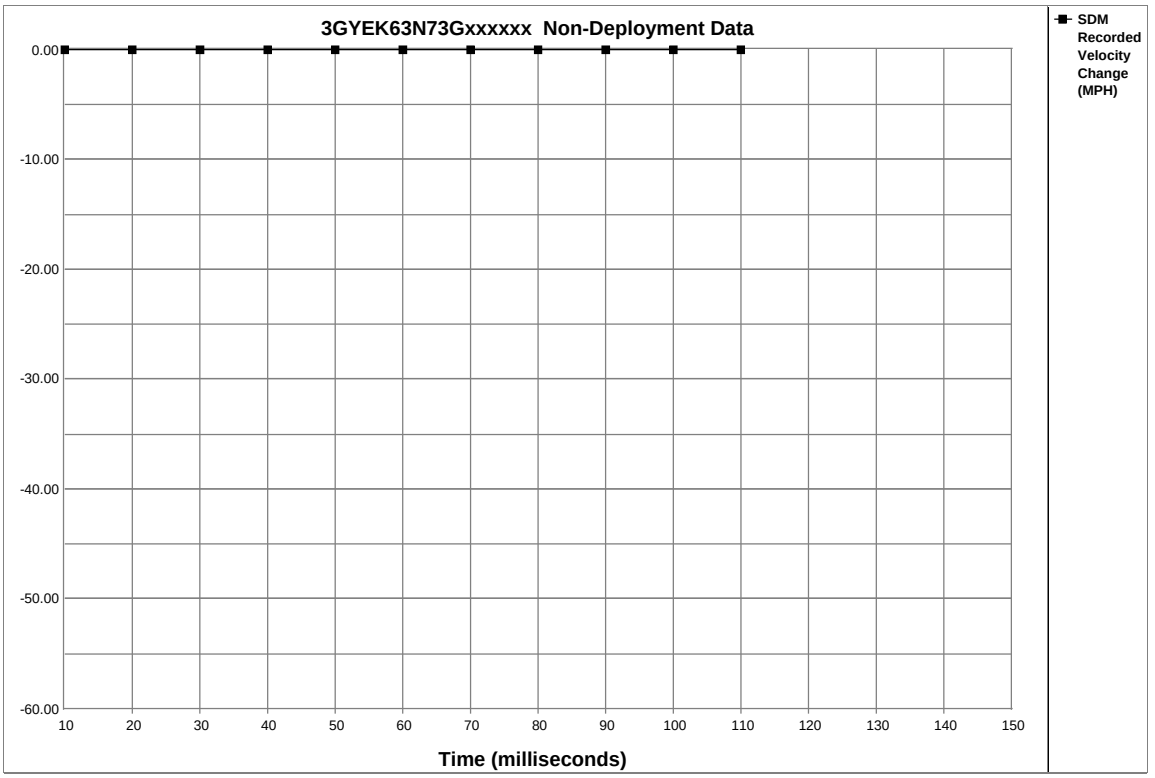


Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	0.00	-0.31	-1.55	-2.17	-3.10	-5.27	-6.20	-6.20	-6.82	-8.37	-9.30	-8.99	-8.99	N/A	N/A

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	828
Ignition Cycles At Investigation	832
Maximum SDM Recorded Velocity Change (MPH)	-0.27
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	60
Event Recording Complete	Yes
Multiple Events Associated With This Record	Yes
One Or More Associated Events Not Recorded	Yes

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	80	2240	35	OFF
-4	80	2240	0	OFF
-3	80	2240	0	OFF
-2	80	2240	0	OFF
-1	80	2240	0	OFF



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
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	N/A	N/A	N/A	N/A

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  F0 21 F7 3C B0 F8
$02  F1 F1 3C 3C A8 00
$03  41 53 32 32 33 34
$04  56 30 50 38 51 31
$05  00 00 00 00 00 00
$06  15 05 78 14 00 00
$07  00 00 00 00 00 00
$08  00 00 00 00 00 00
$09  00 00 00 00 00 00
$0A  00 00 00 00 00 00
$0B  00 00 00 00 00 00
$0C  00 00 00 00 00 00
$0D  00 00 00 00 00 00
$0E  00 00 00 00 00 00
$0F  00 00 00 00 00 00
$10  FF 97 FF 00 00 00
$11  86 83 88 7B 7A 7D
$12  8F 7E 7E 20 1F 01
$13  FF 02 00 00 00 00
$14  03 03 00 00 6C 00
$15  FA FA FA FA FA FA
$16  FA FA FA FA FA FA
$17  FA FA 00 00 00 00
$18  00 3F 55 AC F1 00
$19  09 00 0A 00 00 64
$1A  00 00 00 00 00 00
$1B  00 00 00 00 00 00
$1C  00 0C 00 00 00 00
$1D  00 00 00 00 00 00
$1F  FE 00 00 00 00 00
$20  5E FD 00 00 FF CD
$21  BE F6 FF FF FF FF
$22  FF FF FF FF FF FF
$23  FF FF FF FF FF E7
$24  00 00 0E 00 18 02
$25  12 00 00 03 00 01
$26  00 00 00 00 00 00
$27  00 00 00 00 00 00
$28  00 00 00 0B FF 98
$29  F0 A5 FF FF FF FF
$2A  FF FF FF FF FF FF
$2B  FF FF FF FF FF FF
$2C  FF FF FF FF FF FF
$2D  FF FF 00 00 00 00
$30  B2 FE 00 00 FF FF
$31  FF FF FF FF FF FF
$32  FF FF FF FF FF FF
$33  FF FF FF FF FF FF
$34  00 11 00 12 0E 03
$35  11 00 12 0E 03 11
$36  00 13 0E 03 11 00
$37  13 0E 03 01 E6 31
$38  2C 0F 32 2A 00 00
$39  1F 00 00 03 00 00
$3A  00 01 05 07 0A 11
$3B  14 14 16 1B 1E 1D
$3C  1D 00 00 0D FF 98
$3D  F0 A5 00 00 00 00
$40  80 80 80 7F 7E 00
$41  00 00 00 5A 5A 5A
$42  5A 00 23 23 22 22
$43  22 00 67 FC 00 00
```

```
$44  80 80 80 80 80 00
$45  00 00 00 00 00 00
$46  5A 00 23 23 23 23
$47  23 00 80 FE 00 00
$48  80 80 80 80 80 00
$49  00 00 00 00 00 00
$4A  00 00 23 23 23 23
$4B  23 00 80 FE 00 00
$4C  FF FF FF FF FF FF
$4D  FF FF FF FF FF FF
$4E  FF FF FF FF FF FF
$4F  FF FF FF FF 00 00
$50  83 00 00 FF 80 FE
$51  FF FF F7 FF FF FF
$52  FF FF FF FF FF FF
$53  FF FF FF FF FF FF
$54  E7 00 FF 98 F0 A5
```