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ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION INVESTIGATION

CASE NUMBER - IN08047
LOCATION - TEXAS
VEHICLE - 2001 CADILLAC DEVILLE
CRASH DATE - October 2008

Submitted:

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Prepared for:

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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 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.

Technical Report Documentation Page

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15. *Supplementary Notes* On-site Side Impact Inflatable Occupant Protection Investigation involving a 2001 Cadillac DeVille and a 2005 Cadillac DeVille DTS.			
16. *Abstract* This report covers an On-Site Side Impact Inflatable Occupant Protection Investigation that involved a 2001 Cadillac DeVille and a 2005 Cadillac DeVille DTS, which were involved in an intersection related crash. This on-site investigation focused on the 2001 Cadillac's side impact air bag system and the source of the driver's injury. The 2001 Cadillac's restrained 87-year-old female driver was executing a left turn at a Tee intersection when the vehicle was impacted on the left side plane by the front plane of the 2005 Cadillac. The impact was of sufficient force to trigger deployment of the 2001 Cadillac's driver's seat back-mounted side impact air bag. Both driver's were transported by ambulance to a hospital and both vehicle were towed due to damage. The 2001 Cadillac's driver was treated in the emergency room and released. She sustained a chest contusion due to loading the seat belt.			
17. *Key Words* Side Impact Air Bag Air Bag Deployment Motor Vehicle Traffic Crash Injury Severity		18. *Distribution Statement* General Public	
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TABLE OF CONTENTS IN08047

BACKGROUND IN08047

This on-site investigation focused on the 2001 Cadillac DeVille's side impact air bag system and the source of the driver's injury. This crash was brought to the National Highway Traffic Safety Administration's attention on December 5, 2009 by the sampling activities of the National Automotive Sampling System–General Estimates System. This investigation was assigned on December 12, 2008. The crash involved a 2001 Cadillac DeVille (**Figure 1**) and a 2005 Cadillac DeVille DTS. The crash occurred in October, 2008, at 0725 hours, in Texas and was investigated by the applicable city police department. This contractor inspected the 2001 Cadillac and the crash scene on December 17 and 18, 2008, and interviewed the driver on January 5, 2009. The 2005 Cadillac was not inspected because it could not be located. This report is based on the police crash report, crash scene and vehicle inspections, driver interview, driver medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

Figure 1: The damaged 2001 Cadillac DeVille.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the 2001 Cadillac was traveling was a 2-lane, undivided, city street, traversing in an east-west direction. The trafficway formed a Tee intersection with a 5-lane city street. The roadway had one east lane and one west lane with parking allowed on both sides of the roadway, and the intersection was controlled by a stop sign. There were no pavement markings and the roadway was 12.4 m (40.7 ft) in width. The roadway on which the 2005 Cadillac was traveling was a 5-lane, undivided, city street traversing in a north-south direction. The roadway had 2 north lanes, 2 south lanes and an opposing left turn lane. Each lane was approximatley 4 m (13.1 ft) in width and parking was allowed on both sides of the roadway. The speed limit was 48 km/h (30 mph) for the 2001 Cadillac and 64 km/h (40 mph) for the 2005 Cadillac. At the time of the crash the light condition was daylight, the atmospheric condition was clear, and the roadway pavement was dry, level bituminous. The traffic density was moderate and the site of the crash was a mix of urban commercial and residential apartments. See the Crash Diagram on page 8 of this report.

Pre-Crash: The 2001 Cadillac's restrained 87-year-old female driver was stopped at the stop sign heading west (**Figure 2**). She intended to turn left and travel south. The 2005 Cadillac's 72-year-old restrained female driver was traveling north in the second lane from the right (**Figure 3**) and intended to continue north. The 2001 Cadillac's driver stated during the SCI interview that she looked but

Figure 2: Approach of the 2001 Cadillac to the intersection; arrow shows approach of the 2005 Cadillac

did not see the approaching vehicle and took no actions to avoid the crash. The vehicle's Event Data Recorder (EDR) report indicated that the vehicle was stopped at 5 and 4 seconds prior to Algorithm Enable (AE) and accelerated to 27 km/h (17 mph) at 1 second prior AE.

Crash: As the 2001 Cadillac entered the intersection and the driver initiated a left turn, the front plane of the 2005 Cadillac impacted its left side plane (**Figures 4** and **5**). The 2001 Cadillac's direction of force was within the 10 o'clock sector and the impact force was sufficient to trigger deployment of the driver's seat back-mounted side impact air bag. The impact caused the 2001 Cadillac to rotate slightly couterclockwise and it came to final rest on the inside north lane heading southwest. The 2005 Cadillac remained engaged with the left side of the vehicle and came to final rest heading north.

Post-Crash: The police, emergency medical, and rescue services responded to the crash scene. The 2001 Cadillac's left front door was jammed shut due to damage and rescue personnel cut the door off the vehicle in order to extricate the driver. She was transported by ambulance to a hospital. The driver of the 2005 Cadillac was also transported by ambulance to a hospital. Both vehicles were towed from the scene due to damage.

Figure 3: Approach of the 2005 Cadillac to the impact area, arrows show converging trajectories

Figure 4: Direct damage to the 2001 Cadillac's left front door from impact with the 2005 Cadillac; arrow shows level of bumper contact

Figure 5: Left side damage to 2001 Cadillac from impact with the 2005 Cadillac

CASE VEHICLE

The 2001 Cadillac DeVille was a front wheel drive, 4-door sedan (VIN: 1G6KD54Y51U------) equipped with a 4.6-L, V8 engine, automatic transmission, 4-wheel anti-lock disc brakes, and an EDR. The front row was equipped with a split bench seat (60/40) with separate back cushions, adjustable head restraints, integral lap-and-shoulder belts, a lap belt in the center seating position, redesigned driver and front right passenger frontal air bags, and seat back-mounted side impact air bags. The second row was equipped with a bench seat, integral head restraints, and lap-and-shoulder seat belts. Second row side impact air bags were an option, but

the vehicle was not so equipped. The driver estimated the vehicle's mileage at the time of the crash was 90,121 kilometers (56,000 miles). The vehicle's specified wheelbase was 293 cm (115.3 in).

CASE VEHICLE DAMAGE

Exterior Damage: The 2001 Cadillac's impact with the 2005 Cadillac involved the left side plane. The left front and left rear doors were directly damaged. The left fender was bent outward and had pry marks on it that occurred when the left front door was removed. The direct damage began 52 cm (20.1 in) rear of the left front axle and extended 202 cm (79.5 in) rearward on the left front and rear doors. The level of maximum crush occurred at the lower left front door and corresponded to the crush at the mid sill level. The measurements were therefore taken on the sill because the left front door could not be tied back on the vehicle in such a manner to allow accurate measurements on the door. The residual maximum crush was 21 cm (8.3 in) and occurred at C_4 (**Figure 6**). The sill height was 32 cm (12.6 in) and the height of the maximum crush was 35 cm (13.8 in). The Door Sill Differential was 0 cm because the maximum crush occurred at the mid sill level. The table below shows the vehicle's right side crush profile.

Figure 6: Top view of the 2001 Cadillac's left side crush; each increment on the measurement rods is 5 cm (2 in)

Units	Event	Direct Damage		Field L	C_1	C_2	C_3	C_4	C_5	C_6	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1	202	21	202	3	9	19	21	13	6	-3	-3
in		79.5	8.3	79.5	1.2	3.5	7.5	8.3	5.1	2.4	-1.2	-1.2

The vehicle's left side wheelbase was reduced 3 cm (1.2 in) while the right side wheelbase was extended 2 cm (0.8 in). The induced damage involved the left fender and upper portions of the left front door, B-pillar, and left rear door.

Damage Classification: The 2001 Cadillac's Collision Deformation Classification (CDC) was **10-LPEW-2** (**290** degrees). The Missing Vehicle algorithm of the WinSMASH program calculated the vehicle's total Delta-V as 17 km/h (10.5 mph). The longitudinal and lateral velocity changes were -6 km/h (-3.7 mph) and 16 km/h (9.9 mph), respectively. The results were based only on the vehicle's crush profile and should be considered as a borderline reconstruction of the Delta-V. The EDR recorded a longitudinal Delta V of -9.2 km/h (-5.7 mph) occurring at 120 msec after AE. This EDR model does not capture lateral Delta-V.

The vehicle manufacturer's recommended tire size was P225/60R16. The 2001 Cadillac was equipped with tires of the recommended size. The vehicle's tire data are shown in the table below.

Tire	*Measured Pressure*		*Vehicle Manufacturer's Recommended Cold Tire Pressure*		*Tread Depth*		*Damage*	*Restricted*	*Deflated*
	kPa	psi	kPa	psi	milli-meters	32nd of an inch			
LF	241	35	207	30	8	10	None	No	No
LR	221	32	207	30	6	8	None	No	No
RR	207	30	207	30	8	10	None	No	No
RF	228	33	207	30	8	10	None	No	No

Vehicle Interior: The inspection of the 2001 Cadillac's interior (**Figures 7**) and the detached left front door (**Figure 8**) revealed no discernable evidence of occupant contact. There was no evidence of steering rim deformation or compression of the energy absorbing steering column.

The left front and left rear doors were jammed shut while the right front and right rear doors remained closed and operational. The pre-crash status of all the window glazing was either fixed or closed. The windshield was in place and cracked from impact forces while the remaining glazing was not damaged. There was no discernable evidence of occupant contact on the left front window glazing.

The vehicle sustained seven passenger compartment intrusions and the most severe involved lateral intrusion into the driver's occupant space. The left B-pillar and sill intruded 11 cm (4.3 in) while the left front door's rear lower quadrant intruded an estimated 10 cm (3.9 in).

Figure 7: Driver seating position, steering wheel and instrument panel

Figure 8: Left front door panel; yellow tape shows dent from contact with seat control panel on driver's seat

The 2001 Cadillac was equipped with redesigned driver and front right passenger frontal air bags. The driver's air bag was located within the steering wheel hub and the front right passenger air bag was located within the mid-instrument panel. There was no frontal impact in this crash and neither frontal air bag deployed.

The vehicle was also equipped with front seat back-mounted side impact air bags, which were located within the outboard side of the driver's and front right passenger's seat backs (**Figure 9**). Based on the Holmatro Rescuer's Guide to Vehicle Safety Systems, the vehicle's side impact sensors were located within the lower B pillars. The driver's seat back-mounted side impact air bag deployed in this crash.

Figure 9: Arrow shows the location of the left front seat back-mounted side impact air bag

The deployed driver's side impact air bag (**Figure 10**) was oval and was 35 cm (13.4 in) in width and 38 cm (14.9 in) in height. It deployed through a rectanglar module cover flap that was 8 cm (3.1 in) in width and 21 cm (8.3 in) in height. The air bag was not equipped with vent ports or tethers. Inspection of the air bag revealed two blood transfers on the inside surface. One was 3 cm (1.2 in) in length and was located on the air bags lower rear quadrant. The second was 14 cm (5.5 in) in length and was located on the air bags forward lower quadrant.

Figure 10: The deployed left front seat back-mounted side impact air bag

EVENT DATA RECORDER

The Cadillac's EDR was imaged using version 2.9 of the Bosch Crash Data Retrieval tool and the data was subsequently printed using version 3.2. The image was obtained via connection to the vehicle's diagnostic link connector. The EDR recorded a non-deployment event. The data indicated that the SIR warning lamp was off and the driver's seat belt switch circuit was recorded as buckled. The longitudinal Delta-V reached a value of -9.2 km/h (-5.7 mph) at 120 msec after AE. This EDR model does not capture lateral Delta-V.

The pre-crash data indicated that the vehicle was stopped at 5 and 4 seconds prior to AE. The speed was recorded as 3 km/h (2 mph) at 3 seconds prior to AE and increased to 19 and 27 km/h (12 and 17 mph) at 2 and 1 seconds prior to AE, respectively. The percent throttle was

recorded as 45% at 1 second prior to AE. The EDR also recorded 8 seconds of brake switch data and recorded the brake switch on at 8-4 seconds prior to AE and off at 3-1 seconds prior to AE. The EDR report is attached at the end of this report[1].

MANUAL RESTRAINT SYSTEM

The 2001 Cadillac was equipped with integral lap-and-shoulder belts for the driver and front right passenger and a lap belt for the front center position. The driver's seat belt consisted of continuous loop belt webbing, an Emergency Locking Retractor (ELR), fixed latch plate, and fixed upper anchor. The lap belt was equipped with a locking latch plate. The front right seat belt was equipped with a switchable ELR/Automatic Locking Retractor (ALR), fixed latch plate, and fixed upper anchor. The driver and front right passenger's seat belts also were equipped with buckle-mounted pretensioners, which did not actuate in this crash. The second row seat belts consisted of continuous loop belt webbing, switchable ELR/ALRs, locking latch plates, and fixed upper anchors.

The inspection of the driver's seat belt assembly revealed historic usage marks on the latch plate and the belt webbing had been cut by rescue personnel. The belt webbing was also slightly stiff and had a slight stretched appearance. This evidence indicated that the driver was restrained by the lap-and-shoulder belt, which was supported by the EDR data. The remaining seat positions were unoccupied.

CASE VEHICLE DRIVER KINEMATICS

Based on the SCI interview, the 2001 Cadillac's driver [87-year-old, female; 155 cm and 68 kg (61 in, 149 lbs)] was seated in an upright posture with her back against the seat back. She had her right foot on the accelerator pedal, left foot on the floor, and both hands on the steering wheel. The seat track was adjusted to between the forward-most and middle positions and the seat back was slightly reclined. The head restraint was in the full down position and the distance from the top of the seat to the top of the head restraint was 18 cm (7.1 in). The tilt steering column was located in the full down position and the driver was wearing glasses.

The 2001 Cadillac's left side impact with the 2005 Cadillac displaced the driver left and forward opposite the 10 o'clock direction of force and she loaded the lap-and-shoulder belt. While there was no discernable evidence of occupant contact on the seat back-mounted side impact air bag, occupant kinematic principles indicate that the left side of the driver's torso loaded the side impact air bag; although no injuries were documented due to this probable contact. The driver sustained a contusion on the chest due to loading the seat belt. She stated that she suffered from pain to her chest and left side following her treatment.

[1] Please note that pages 5 and 6 of the EDR report have been deleted for confidentiality reasons.

The driver was transported by ambulance to a hospital where she was treated in the emergency room and released. The table below shows the driver's injury and injury source.

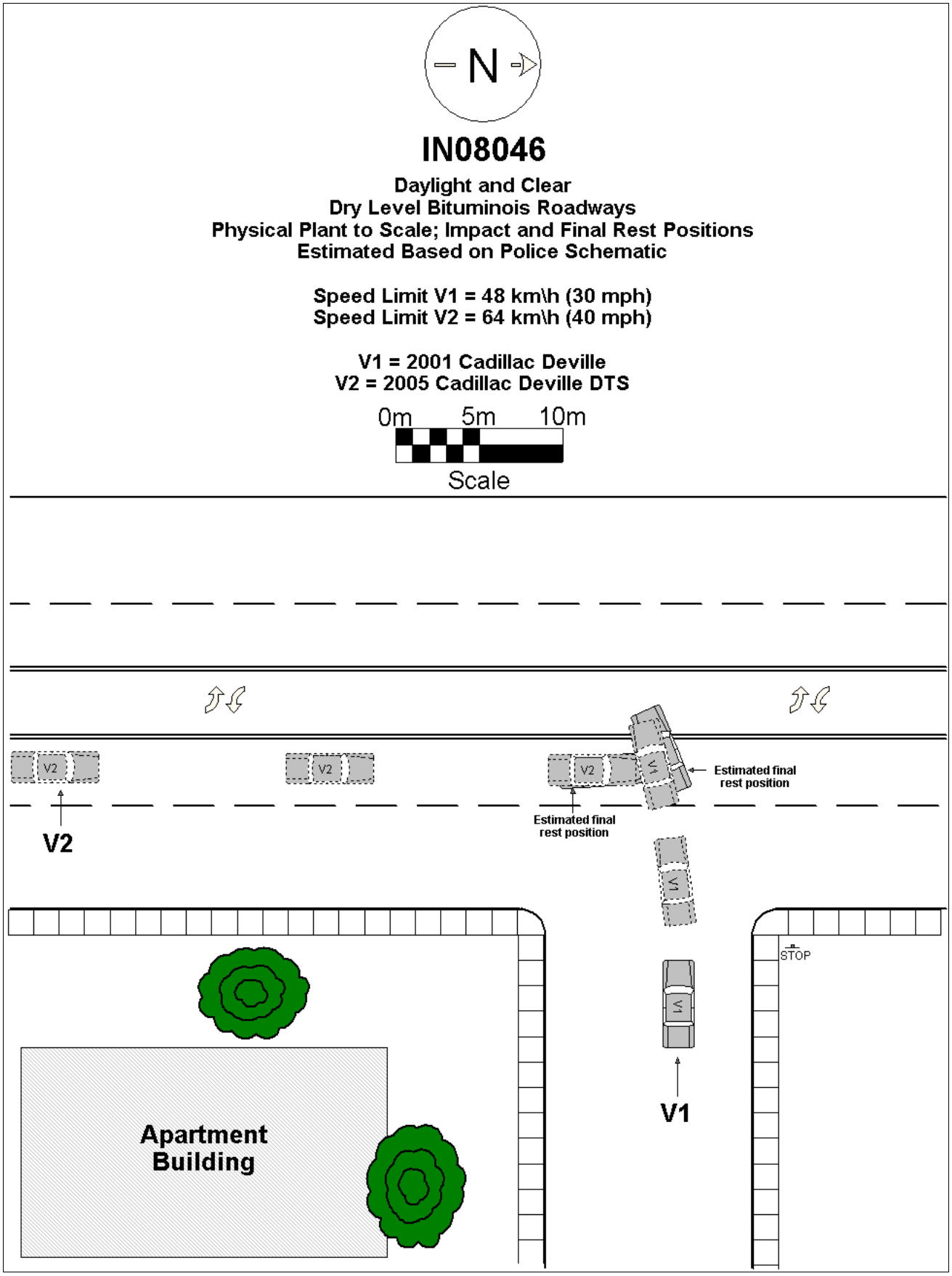
Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source	Source Confidence	Source of Injury Data
1	Contusion chest wall with pain over sternal area	minor 490402.1,4	Torso portion of safety belt system	Probable	Emergency room records

OTHER VEHICLE

The 2005 Cadillac was a front wheel drive, 4-door, sedan (VIN: 1G6KF57985U------) equipped with a 4.6-L, V8 engine, automatic transmission, 4-wheel anti-lock disc brakes, traction control, and dual stage driver and front right passenger frontal air bags. This vehicle was not inspected because it could not be located.

Damage Classification: The Missing Vehicle algorithm of the WinSMASH program calculated the vehicle's total Delta-V for the front impact as 17.0 km/h (10.6 mph). The longitudinal and lateral velocity changes were -17 km/h (-10.5 mph) and -3 km/h (1.9 mph), respectively. The results were based only on the 2001 Cadillac's crush profile and should be considered a borderline reconstruction the 2005 Cadillac's Delta-V.

Other Vehicle's Driver: The police crash report indicated that the driver (72-year-old, female) was restrained by the lap-and-shoulder belt and the driver's air bag did not deploy. The driver sustained an A (incapacitating) injury.


N
IN08046
Daylight and Clear
Dry Level Bituminois Roadways
Physical Plant to Scale; Impact and Final Rest Positions
Estimated Based on Police Schematic
Speed Limit V1 = 48 km\h (30 mph)
Speed Limit V2 = 64 km\h (40 mph)
V1 = 2001 Cadillac Deville
V2 = 2005 Cadillac Deville DTS
0m 5m 10m
Scale
V2
V2
V2
V1
Estimated final rest position
Estimated final rest position
V1
V1
V2
STOP
Apartment Building

CDR File Information

User Entered VIN	1G6KD54Y51U******
User	
Case Number	
EDR Data Imaging Date	
Crash Date	
Filename	IN08047.CDR
Saved on	Thursday, December 18 2008 at 01:54:21 PM
Collected with CDR version	Crash Data Retrieval Tool 2.900
Reported with CDR version	Crash Data Retrieval Tool 3.2
EDR Device Type	airbag control module
Event(s) recovered	Non-Deployment

IMPORTANT NOTICE: Robert Bosch LLC recommends that the latest production release of Crash Data Retrieval software be utilized when viewing, printing or exporting any retrieved data from within the CDR program. This ensures that the retrieved data has been translated using the most recent information including but not limited to that which was provided by the manufacturers of the vehicles supported in this product.

Data Limitations

Recorded Crash Events:

There are two types of Recorded Crash Events. The first is the Non-Deployment Event. A Non-Deployment Event records data but does not deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event may be overwritten by another Non-Deployment Event. This event will be cleared by the SDM, after approximately 250 ignition cycle. This event can be overwritten by a second Deployment Event, referred to as a Deployment Level Event, if the Non-Deployment Event is not locked. The data in the Non-Deployment Event file will be locked, if the Non-Deployment Event occurred within five seconds before a Deployment Event. A locked Non Deployment Event cannot be overwritten or cleared by the SDM.

The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. If a Deployment Level Event occurs within five seconds after the Deployment Event, the Deployment Level Event will overwrite any non-locked Non-Deployment Event. Deployment Events cannot be overwritten or cleared by the SDM. Once the SDM has deployed an air bag, the SDM must be replaced.

Data:

-SDM Recorded Vehicle Longitudinal Velocity Change reflects the change in longitudinal velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Longitudinal Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. For Deployment Events, the SDM will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM will record up to the first 150 milliseconds of data after algorithm enable. Velocity Change data is displayed in SAE sign convention.

-SDM Recorded Vehicle Speed accuracy can be affected by various factors, including but not limited to the following:

- -significant changes in the tire's rolling radius
- -final drive axle ratio changes
- -wheel lockup and wheel slip

-Brake Switch Circuit Status indicates the open/closed state of the brake switch circuit.

-Pre-Crash data is recorded asynchronously.

-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if:

- -the SDM receives a message with an "invalid" flag from the module sending the pre-crash data
- -no data is received from the module sending the pre-crash data
- -no module present to send the pre-crash data

-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Driver's Belt Switch Circuit may be reported other than the actual state.
-Passenger Front Air Bag Suppression Switch Circuit Status indicates the status of the suppression switch circuit.
-The Time Between This Event and the Previous Events is displayed in seconds. If the time between the two events is greater than five seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-If the vehicle is a 2000 - 2002 Chevrolet Cavalier Z24 or a Pontiac Sunfire GT, with a manual transmission (RPO MM5) and a 2.4L engine (RPO LD9), the Brake Switch Circuit Status data will be reported in the opposite state than what actually occurred, e.g. an actual brake switch status of "ON" will be reported as "OFF".
-All data should be examined in conjunction with other available physical evidence from the vehicle and scene.

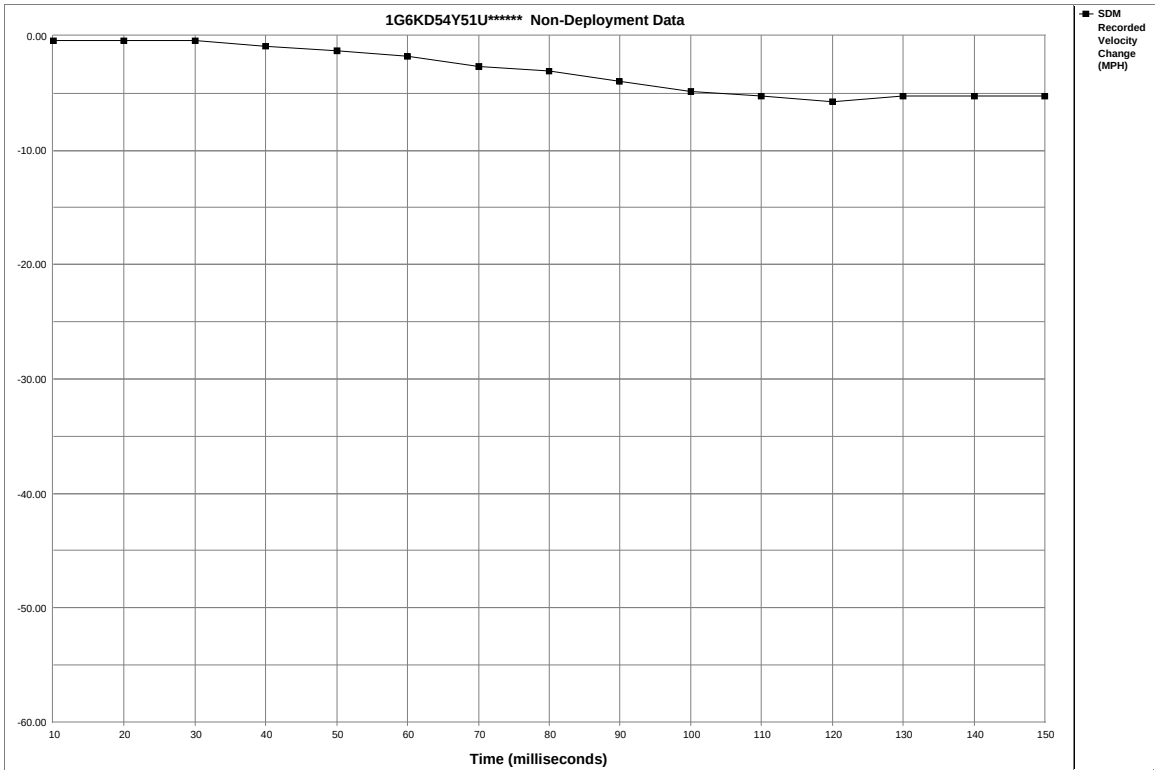
Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the vehicle's communication network, to the SDM.
-The SDM may obtain Belt Switch Circuit Status data a number of different ways, depending on the vehicle architecture. Some switches are wired directly to the SDM, while others may obtain the data from various vehicle control modules, via the vehicle's communication network.
-The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Non-Deployment	10911
Ignition Cycles At Investigation	10918
Maximum SDM Recorded Velocity Change (MPH)	-5.80
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	190

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle
-5	0	640	3
-4	0	640	3
-3	2	1728	29
-2	12	2048	35
-1	17	2496	45

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



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	-0.44	-0.44	-0.44	-0.88	-1.32	-1.76	-2.63	-3.07	-3.95	-4.83	-5.27	-5.70	-5.27	-5.27	-5.27