

Rollover Investigation / Vehicle to Object
Dynamic Science, Inc. / Case Number: DS07005
2006 Chevrolet Colorado
California
December 2006

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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.

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16. Abstract This on-site investigation focused on the rollover event and the Certified Advanced 208-Compliant air bag system in a 2006 Chevrolet Colorado pickup. The manufacture of this vehicle certified that it met the requirements of Federal Motor Vehicle Safety Standard No. 208. This single vehicle crash occurred in December 2006 at 0030 hours. The crash occurred in northbound lanes of a four-lane divided interstate highway. The case vehicle was being driven by a 25-year-old male. The driver of a non-contact vehicle apparently changed lanes to the right. The driver of the case vehicle steered to the right, crossed a narrow shoulder, and struck a concrete barrier on the right side of the roadway. The vehicle then rolled onto its left side. The vehicle came to rest blocking the second and third lanes of traffic. There were no reported injuries.				
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BACKGROUND

This on-site investigation focused on the rollover event and the Certified Advanced 208-Compliant air bag system in a 2006 Chevrolet Colorado pickup. This single vehicle crash occurred in December 2006 at 0030 hours. The crash occurred in northbound lanes of a four-lane divided interstate highway. The case vehicle was being driven by a 25-year-old male. The driver of a non contact vehicle apparently changed lanes to the right. The driver of the case vehicle steered to the right, crossed a narrow shoulder, and struck a concrete barrier on the right side of the roadway. The vehicle then rolled onto its left side. The vehicle came to rest blocking the second and third lanes of traffic.

This Rollover case was identified by the National Highway Traffic Safety Administration (NHTSA) during a review of police reports. DSI was faxed the report on January 19, 2006. DSI located the case vehicle and obtained permission to inspect the vehicle on February 9, 2007 and was assigned the case on February 12, 2007. The vehicle was inspected February on 13, 2007 and field work was completed on February 26, 2007.

SUMMARY

Crash Site

This single vehicle crash occurred in December 2006 at 0030 hours. The crash occurred in the northbound lanes of a four-lane divided interstate highway. The road surface was composed of concrete and was dry at the time of the crash. The roadway was bordered on the left by a solid yellow line and a concrete wall and on the right by a solid white line and a concrete barrier. At the end of the barrier on the right was a curbed area that separated the roadway from merging northbound traffic. There was a delineator of some type on the curb area at one time. It was dark at the time of the crash and the streetlights were illuminated. The posted speed limit at this location was 105 km/h (65 mph).



Figure 1. 2006 Chevrolet S10, left side rollover damage



Figure 2. Front right bumper corner damage



Figure 3. Approach to area of impact (north)

Pre-Crash

The case vehicle was a 2006 Chevrolet Colorado crew cab pickup that was being driven by a 25-year-old male. The vehicle was traveling northbound in the far right hand lane at a driver stated speed of 113 km/h (70 mph). The Event Data Recorder (EDR) recorded the speed five seconds before Algorithm Enable (AE) as 116 km/h (72 mph). The speed one second before AE was recorded at 105 km/h (65 mph). According to the driver, there was a black Chevrolet Camaro traveling in the lane to the left.



Figure 4. Area of impact (north)

Crash

The driver of the Camaro put on his turn signal and began to change lanes to the right. The driver of the Chevrolet Colorado steered to the right, crossed a narrow shoulder, and struck end of the concrete barrier and the curb with the right side of the front bumper and the right front tire. The tire blew out and the vehicle began a clockwise rotation. The front of the vehicle, at the air dam level, scraped along the curb. There were indications that the Colorado contacted a delineator with the hood and bumper as the vehicle rotated. The vehicle continued rotating until it tripped and rolled onto its left side. The vehicle came to rest blocking the second and third traffic lanes.

Post-Crash

The Chevrolet Colorado pickup was towed from the scene due to damage. It was later declared a total loss by the insurance company. The driver was able to exit the vehicle under his own power. There were no reported injuries.

VEHICLE DATA -2006 Chevrolet Colorado

The 2006 Chevrolet Colorado crew cab pickup was identified by the Vehicle Identification Number (VIN): 1GCCS136868xxxxxx. The Colorado was equipped with a 3.5 liter, 5-cylinder engine, rear wheel drive, a four speed automatic transmission, front disc/rear drum brakes with ABS, power steering and a tilt steering wheel. The Colorado was configured with General Ameri-GS60 P225/75R15 tires. The tire manufacturer's maximum pressure was 303 kPa (44 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	179 kPa (26 psi)	5 mm (6/32 in)	No	Sidewall scuffed
RF	Flat	5 mm (6/32 in)	No	Tire torn, flattened
LR	186 kPa (27 psi)	5 mm (6/32 in)	No	Sidewall scuffed
RR	186 kPa (27 psi)	5 mm (6/32 in)	No	Bulge in sidewall

The seating in the Colorado was configured with front split-bench 60-40 seats with integral head restraints and a rear 60-40 bench seat. The driver's seat was located in the full rearward track position. The front right passenger seat was located 4 cm (1.6 in) forward of the full rearward track position. The driver's seat back angle was 21 degrees from vertical; the seat cushion angle was 10 degrees from horizontal. The front right passenger's seat back angle was 26 degrees from vertical; the seat cushion angle was 11 degrees from horizontal.

Vehicle Damage

Exterior Damage - 2006 Chevrolet Colorado pickup

The 2006 Chevrolet pickup sustained minor damage to right front of the vehicle due to contact with the barrier and curb. The direct damage began at the front right bumper corner area and extended 84 cm (33.0 in) rearward along the right side, including contact to the rim. The rim was damaged and the tire was flattened. As the vehicle began a clockwise rotation, the front of the vehicle contacted the curb. There was 36 cm (14.2 in) direct contact to the air dam that began 5 cm (2.0 in) right of the vehicle center line. The vehicle also struck a delineator post with its front end. There was 8 cm (3.1 in) direct damage to the hood line that began 11 cm (4.3 in) left of the vehicle center line. There was 7 (2.8 in) direct contact to the bumper that began 3 cm (1.2 in) left of the vehicle center line. The Collision Deformation Classification (CDC) for the initial barrier impact was 12RFES2. The CDC for the curb impact was 10FZLN1. The CDC for the delineator impact was 10FCEN1.



Figure 5. Initial impact, right corner

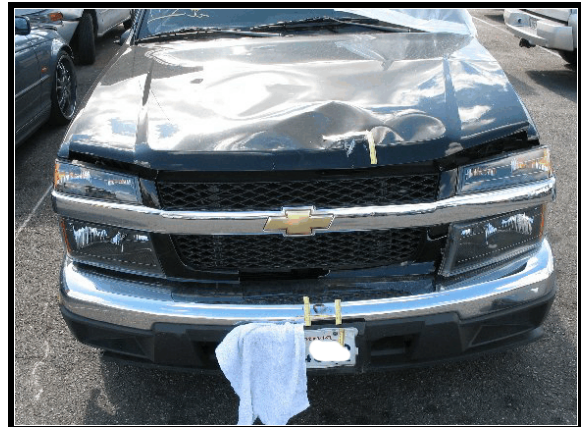


Figure 6. Contact damage during rotation

There was moderate damage to the left side of the vehicle that occurred during the rollover. There was 490 cm (192.9 in) direct contact that extended 60 cm (23.6 in) forward of the front axle to the left tail light. The height of the direct damage on the left side was 115 cm (45.3 in). Maximum crush of 2 cm (0.8 in) was located at the B pillar. The CDC for the rollover was 00LDAO2.



Figure 7. Overview of left side rollover damage

The mirror on the left side was knocked off as was the handle to the left rear door. All doors, however, remained closed and operational.

Interior Damage - 2006 Chevrolet Colorado pickup

The 2006 Chevrolet Colorado sustained minor interior damage as a result of passenger compartment intrusion. There was a small amount of lateral intrusion (4 cm/1.6 in) to the left front door panel near the A-pillar and a negligible amount of lateral intrusion (1 cm/0.4 in) to the left roof side rail. There were no indications of any occupant loading to interior components.

The left front side glass disintegrated during the rollover. The glass was tinted using a plastic film. The film held the glass fragments in place. The windshield was fractured on the left side, primarily near the left A-pillar.

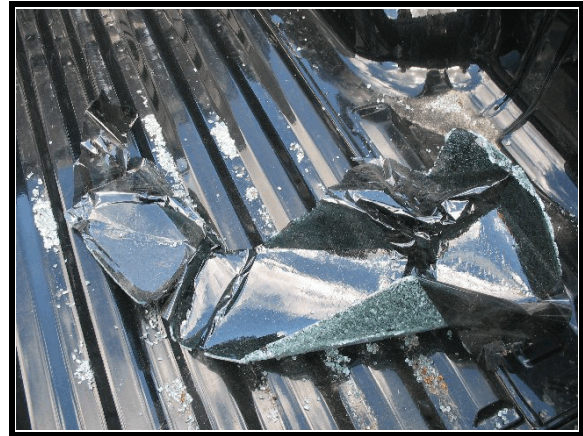


Figure 8. Left front side glass

All the doors remained closed and operational. The exterior handle for the left rear door was knocked off, but the door could open using the remaining components.

Manual Restraints - 2006 Chevrolet Colorado pickup

The 2006 Chevrolet Colorado pickup was configured with manual 3-point lap and shoulder belts in the front outboard seating positions and all three rear seating positions. Both front seat safety belts were equipped with retractor pretensioners that did not actuate, and adjustable D-rings. The driver's adjustable D-ring was in the full up position; the front right passenger D-ring was in the full down position. There were indications of historical usage on both front seat belts, but no indications that they were used in this crash.

The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The remaining lap and shoulder safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The front seat middle seat position was equipped with a lap belt.

The second row outboard seating positions were equipped with the lower anchor points that were part of this vehicle's Lower Anchors and Tethers for Children (LATCH) system. The outboard second row seating positions were equipped with child safety seat tether anchor points.

Supplemental Restraint Systems - 2006 Chevrolet Colorado pickup

The 2006 Chevrolet Colorado pickup was equipped with dual-stage advanced air bags. The air bag system consisted of the Sensing and Diagnostic Module (SDM) driver and front right passenger air bags, and a driver's seat belt latch usage detector. The system is controlled by the SDM. The primary function of the SDM is to control the deployment of the occupant protection systems. The system records the vehicle's forward velocity change. The system has the ability to record three types of events: Deployment Events, Deployment Level Events, and Non-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 the first 150 milliseconds of data after algorithm enable (AE).

The 2006 Chevrolet Colorado pickup's EDR was downloaded by the SCI investigator and the EDR summary report is included as Attachment 2 at the end of this report. The system recorded a Non Deployment Event.

The Vetronix system status at Non Deployment report indicated the following:

1. SIR warning lamp status was OFF.
2. The driver's belt switch status was UNBUCKLED.
3. Ignition cycles at non deployment 1880.
4. Ignition cycles at investigation 1894.
5. Maximum SDM recorded longitudinal velocity change was -1.0 km/h (-0.68 mph) at 40 milliseconds.
6. Vehicle speed was reported to be 116 km/h (72 mph) five seconds before AE and had decelerated to 105 km/h (65 mph) one second before AE.
7. The brake switch status was OFF throughout.

The Chevrolet Colorado was equipped with front retractor pretensioners that did not actuate.

Rollover Dynamics

The Colorado was equipped with a four speed automatic transmission, front disc/rear drum brakes with ABS, and power steering. The Colorado had a four-star Rollover Resistance Rating (RRR) with a 10 to 20 percent chance of rollover and a Static Stability Factor (SSF) of 1.25. As the driver of Colorado steered to the right, the vehicle crossed a narrow shoulder, and struck end of the concrete barrier and the curb with the right side of the front bumper and the right front tire. The tire blew out and the vehicle began a clockwise rotation. The vehicle continued rotating until it tripped and rolled one quarter turn onto its left side. The vehicle came to rest blocking the second and traffic third lanes.

OCCUPANT DEMOGRAPHICS - 2006 Chevrolet Colorado

	Driver
Age/Sex:	25/Male
Seated Position:	Front left
Seat Type:	Split bench with separate back cushion
Height:	180 cm (71 in)
Weight:	88 kg (195 lbs)
Occupation:	Unknown

Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Upright
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, not used
Air bag:	Steering wheel mounted frontal air bag, did not deploy

OCCUPANT INJURIES -2006 Chevrolet Colorado

Driver: No reported injuries.

OCCUPANT KINEMATICS - 2006 Chevrolet Colorado

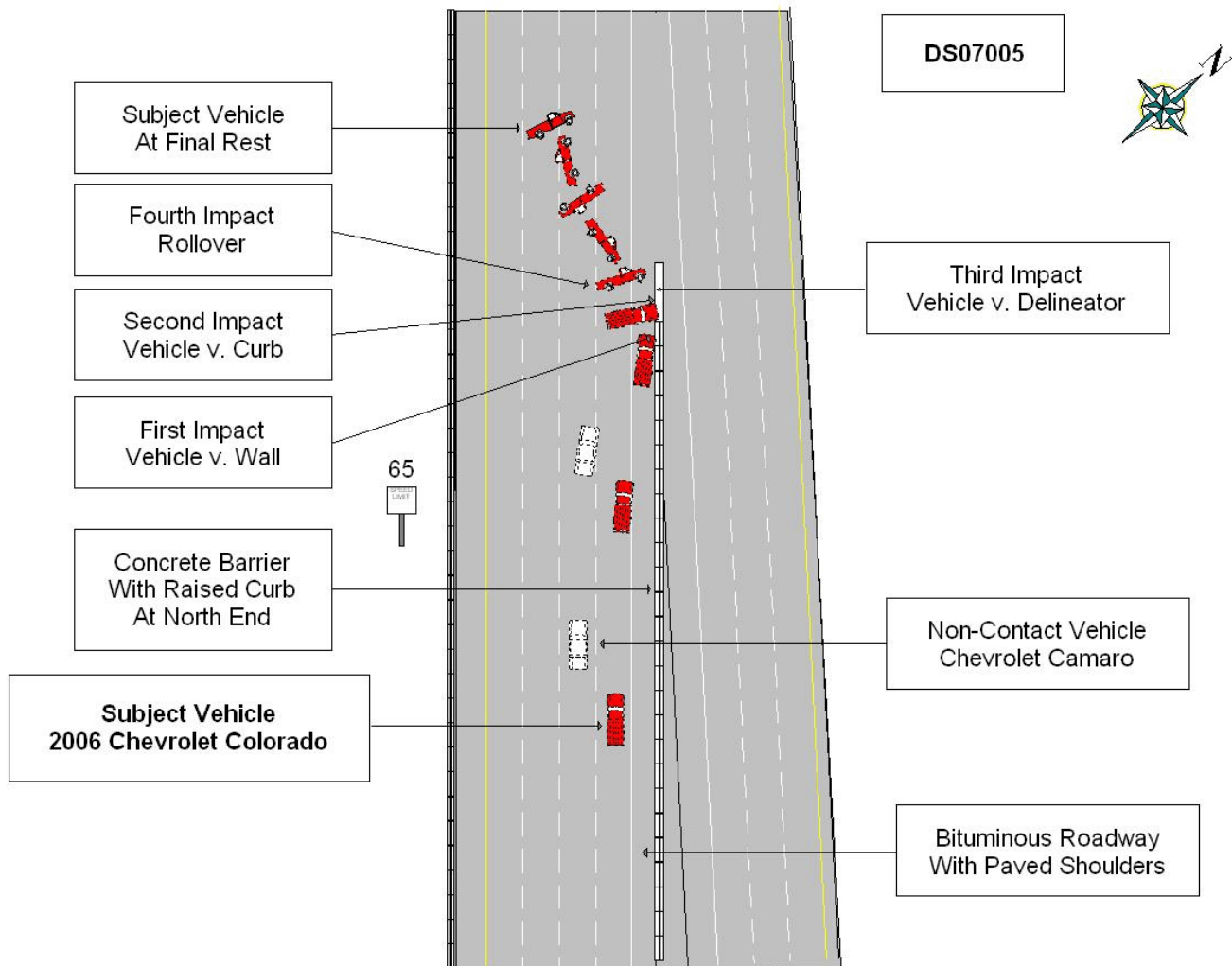
Driver Kinematics

The 25-year-old male driver was likely seated in an upright manner and was not restrained by the manual lap and shoulder belt. The seat track was in the full rearward position. The seat back angle was 21 degrees from vertical; the seat bottom angle was 10 degrees from horizontal. There were no indications of any driver braking. At impact with the curb, the driver did not experience any significant motion and stayed in place. As the tire deflated, and the vehicle began its clockwise rotation, the driver was displaced slightly to the left. As the vehicle overturned onto its left side, the driver contacted the side door panel, but there were no indications of any damage or injury. The driver was able to exit the vehicle under his own power. There were no reported injuries.



Figure 9. Driver's seated position

Attachment 1. Scene Diagram



Attachment 2. Vetronix Readout



CDR File Information

Vehicle Identification Number	1GCCS136868*****
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	07005.CDR
Saved on	Tuesday, February 13 2007 at 11:10:25 AM
Collected with CDR version	Crash Data Retrieval Tool 2.800
Collecting program verification number	9238B95E
Reported with CDR version	Crash Data Retrieval Tool 2.800
Reporting program verification number	9238B95E
Interface used to collected data	Block number: 00 Interface version: 4A Date: 11-08-05 Checksum: 7500
Event(s) recovered	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 25.4 seconds of one another. Deployment Events cannot 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 Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event. If multiple Non-Deployment Events occur within 5 seconds prior to a Deployment Event, then the most severe Non-Deployment Event will be recorded and locked. If multiple Non-Deployment Events precede a Deployment Event, and multiple Non-Deployment Events occur within 5 seconds of each other (but not necessarily all within 5 seconds of the Deployment Event), and subsequent Non-Deployment Events are less severe than prior Non-Deployment Events, and the last of the multiple Non-Deployment Events occurs within 5 seconds of a Deployment Event, then the most severe of the Non-Deployment Events (which may have occurred more than 5 seconds prior to the Deployment Event) will be recorded and locked.

SDM Data Limitations:

-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. For Deployment Events and Deployment Level 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 the first 150 milliseconds of data 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 receive an invalid message from the module sending the pre-crash data.

-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Belt Switch Circuit may be reported other than the actual state.

-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.

-Multiple Events Associated with this Record: This parameter will indicate whether one or more associated events preceded the recorded event.

-One or More Associated Events Not Recorded: If a single event is recorded, this parameter will indicate whether one or more associated events, prior to the recorded event, was not recorded.

If two associated events are recorded, this parameter for the first event will indicate whether one or more associated events, prior to the first event, was not recorded.

If two associated events are recorded, this parameter, for the second event, will indicate whether one or more associated



events, between the first and second events, was not 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 vehicle's communication network, to the SDM.

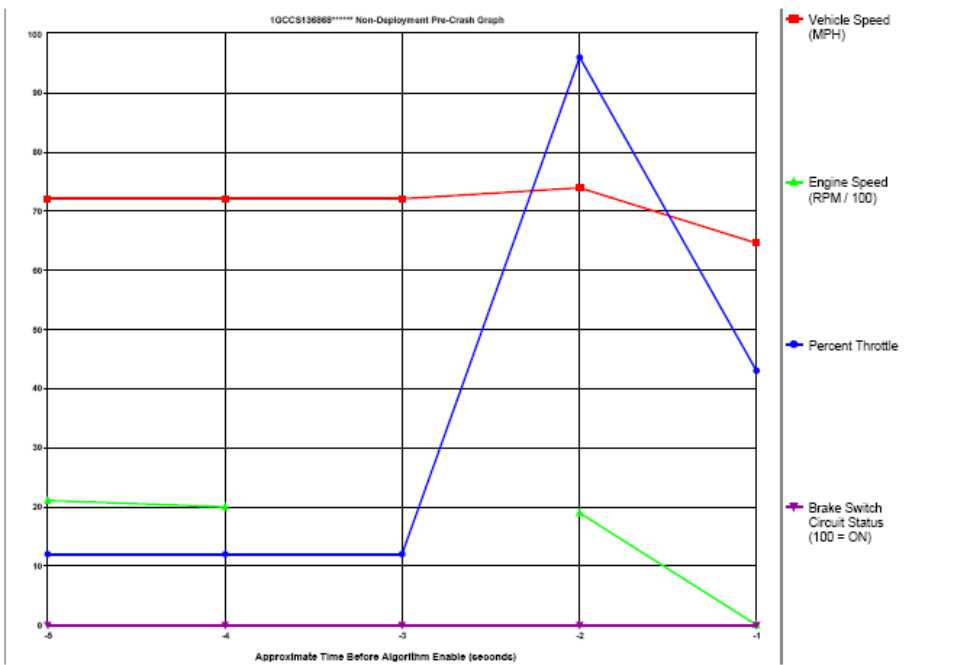
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the vehicle's communication network, to the SDM.

-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.

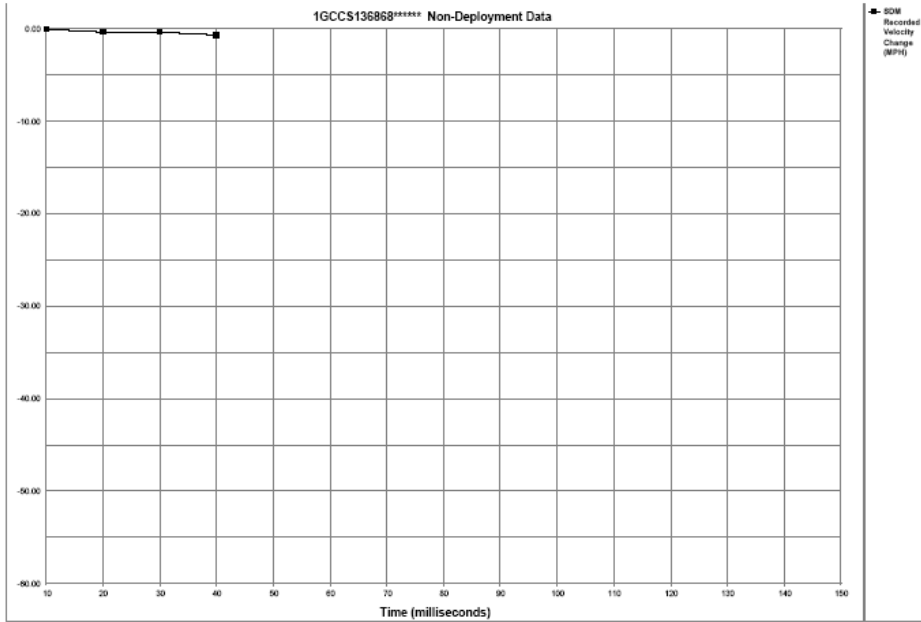


System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger's Belt Switch Circuit Status	UNBUCKLED
Passenger Seat Position Switch Circuit Status	Rearward
Ignition Cycles At Non-Deployment	1880
Ignition Cycles At Investigation	1894
Maximum SDM Recorded Velocity Change (MPH)	-0.68
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	45
Crash Record Locked	No
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	72	2112	12	OFF
-4	72	2048	12	OFF
-3	72	Invalid	12	OFF
-2	74	1856	96	OFF
-1	65	0	43	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	-0.31	-0.62	N/A	N/A	N/A	N/A	N/A	N/A	N/A	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.

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$14 1D 1D 00 00 64 40
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