

Certified Advanced 208-Compliant (CAC) Vehicle Investigation / Vehicle to Object  
Dynamic Science, Inc. / Case Number: 2004-50-129G  
2004 Chevrolet 1500  
Texas  
October, 2004

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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 crash-worthiness performance of the involved vehicle(s) or their safety systems.*

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16. Abstract This combination investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) air bag system in a 2004 Chevrolet 1500 pickup. This single vehicle crash occurred in October, 2004 at 0245 hours. The crash occurred in the median area of a curved six-lane divided roadway. The case vehicle is a 2004 Chevrolet 1500 4x2 full size pickup that was being driven by an unrestrained 24-year-old male. The pickup was equipped with dual stage front air bags. The front right air bag was equipped with a shut off switch that was set to the AUTO position. The Chevrolet pickup was traveling southbound at an unknown speed in the third lane from the right. The driver had been drinking. As the vehicle entered the curve, the driver lost control and began a counterclockwise rotation. The Chevrolet entered the median and struck a tree that was roughly in the center of the median with its front end. The driver's air bag deployed at this point. The Chevrolet rotated about the tree in a counterclockwise fashion while continuing to travel south in the median. After the vehicle had rotated approximately 270 degrees, the Chevrolet then struck a second tree with its left side. The Chevrolet spun out from this impact and back onto the roadway where it came to rest in the center lane facing west. The driver was able to exit the vehicle on his own. He sustained minor contusions to the right elbow and right knee. He was not medically treated.				
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**Dynamic Science, Inc.**  
**Crash Investigation**  
**Case Number: 2004-50-129G**

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## BACKGROUND:

**Description:** This remote/combination investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) air bag system in a 2004 Chevrolet 1500 pickup. This CAC Vehicle Investigation was identified by the local National Automobile Sampling System (NASS) Primary Sampling Unit (PSU). A CAC vehicle is certified by the manufacturer to be compliant to Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

**Investigation Type:** Combination  
**Crash Location:** Texas  
**Crash Date:** October, 2004  
**Notification Date:** November 24, 2004  
**Field Work Completed:** Remote

## SUMMARY

### Crash Site

This single vehicle crash occurred in October, 2004 at 0245 hours. The crash occurred in the median area of a left hand curved six-lane divided roadway. The median separates southbound from northbound traffic. The median was approximately 4.8 m (16 ft) wide, grass covered, with a series of trees running down the middle of the median. Both edges of the median were bordered by raised concrete curbs. It was dark at the time of the crash and there were no streetlights. The concrete roadway was wet and there was a downward grade. The three southbound lanes are separated by painted dashed white lines. There were no traffic controls. The speed limit for this area is 56 km/h (35 mph).



**Figure 1.** Approach to area of road departure (south)

### Pre-Crash

The case vehicle is a 2004 Chevrolet 1500 4x2 full size pickup (VIN:2GCEC19V1413xxxx) that was being driven by an unrestrained<sup>1</sup> 24-year-old male (180 cm/71 in, 71 kg/157 lbs). The driver was seated on a bench seat with separate back cushions. The seat was adjusted to between the forward most and middle track positions. The seat back was slightly reclined. The pickup was

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<sup>1</sup>Based on damage to windshield, visor, contacts to knee bolster, and EDR buckle status (unbuckled). SCI change.

equipped with dual stage front air bags. The front right air bag was equipped with a shut off switch that was set to the AUTO position. The Chevrolet pickup was traveling southbound at an unknown speed in the third lane from the right. The Vetronix report indicates a speed of 97 km/h (60 mph) one second prior to Algorithm Enable (AE). The driver had been drinking. As the vehicle entered the curve, the driver lost control and began a counterclockwise rotation on the wet roadway.

### Crash

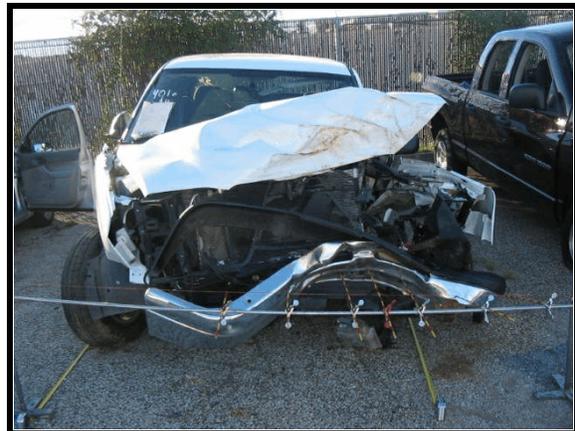
The Chevrolet entered the median and struck a tree that was roughly in the center of the median with its front end (81FDEW2). The total velocity change calculated by the damage only algorithm of the WinSmash collision model was 30.0 km/h (18.6 mph). The longitudinal and lateral components were -26.0 km/h (-16.2 mph) and -15.0 km/h (-9.3 mph), respectively. The barrier equivalent speed was calculated as 30.0 km/h (18.6 mph). The System Diagnostic Module (SDM) recorded a velocity change of -26.60 km/h (-16.53 mph). The driver's air bag deployed at this point. The Chevrolet rotated about the tree in a counterclockwise fashion while continuing to travel south in the median. After the vehicle had rotated approximately 270 degrees, the Chevrolet then struck a second tree with its left side (07LBEE2). The Chevrolet spun out from this impact and back onto the roadway where it came to rest in the center lane facing west.



**Figure 2.** Area of roadway departure (south)



**Figure 3.** Shows first tree impact (foreground) and second tree impact (background)



**Figure 4.** Front, 2004 Chevrolet pickup (impact 1)

## Post-Crash

The driver sustained contusions to his right knee and right elbow, and an abdominal muscle strain<sup>2</sup>. He did not receive any medical treatment. He was able to exit the vehicle on his own. He failed a field sobriety test and was cited for driving under the influence of alcohol. The case vehicle was subsequently impounded.



Figure 5. Left side, impact 2

## VEHICLE DATA - 2004 Chevrolet 1500

The Chevrolet 1500 4x2 ½ ton extended cab pickup truck was equipped with 4.8 liter V 8 engine, 4-speed automatic transmission, front disc/rear drum brakes with ABS, rack and pinion steering, and a tilt steering wheel.

VIN:	VIN:2GCEC19V1412xxxxx
Odometer:	38,624 km (24,000miles)
Reported Defects:	None reported
Cargo:	7.0 kg (15.4 lbs), per inspection

The 2004 Chevrolet 1500 will carry up to six passengers—three in the front row seat and three in the second row seat. The front seating positions were configured with a fabric covered bench seat with separate back cushions. The driver’s seat was adjusted to between the forward most and middle track positions. The middle seat was not adjustable. The front right passenger’s seat was adjusted to the middle track position. Both outboard seat backs were slightly reclined. Both outboard seat positions were configured with adjustable head restraints that were not damaged. The second row seating positions were configured with a fabric covered bench seat with a folding back. The seat track was not adjustable. Both outboard second row seat positions were configured with adjustable head restraints that were not damaged.

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<sup>2</sup>The driver also reported a fracture to the right foot. This injury was not coded.

The 2004 Chevrolet 1500 was equipped with Goodyear Wrangler ST P235/75R16 tires. The specific tire data is as follows:

<b>Tire</b>	<b>Tread</b>	<b>Measured pressure</b>	<b>Manufacturer recommended pressure</b>	<b>Restricted</b>	<b>Damage</b>
LF	6 mm (0.2 in)	Flat	303 kPa (44 psi)	Yes	Cut
LR	6 mm (0.2 in)	221 kPa (32 psi)	303 kPa (44 psi)	No	None
RF	6 mm (0.2 in)	248 kPa (36 psi)	303 kPa (44 psi)	No	None
RR	6 mm (0.2 in)	76 kPa (11 psi)	303 kPa (44 psi)	No	None

## VEHICLE DAMAGE

### Exterior Damage - 2004 Chevrolet 1500

Damage Description: Moderate front end damage to the front bumper, grille, hood. Front end shifted to the left. Minor contact damage to left rear bumper corner area. Vehicle towed from the scene due to disabling damage.

CDC: Impact 1: 81FDEW2

Impact 2: 07LBEE2

Delta V (Impact 1):	Total	30.0 km/h (18.6 mph)
	Longitudinal	-26.0 km/h (16.1 mph)
	Latitudinal	-15.0 km/h (9.3 mph)
	Energy	110,530 joules (81,522 ft-lbs)

There was 140.0 cm (55.1 in) of direct and induced damage to the front end from the first tree impact. The direct damage began 14.0 cm (5.5 in) from the front right bumper corner and extended laterally 80.0 cm (31.5 in). The residual crush measured along the bumper was as follows: C1=49.0 (19.3 in), C2 =26.0 cm (10.2 in), C3=44.0 cm (17.3 in), C4=43.0 cm (16.9 in), C5=10.0 cm (3.9 in), C6=0 cm (0 in).



Figure 6. Front left, Chevrolet 1500

### Interior Damage - 2004 Chevrolet 1500

Interior damage to the 2004 Chevrolet was as a result of occupant contact and normal damage associated with an air bag deployment. There was scuffing observed on the sun visor, left side of the knee bolster, and to the face of the driver's air bag. The center console was shifted to the right. The windshield was cracked due to occupant contact. There was no other glazing damage. Both front doors remained closed and operational; there was no intrusion nor any integrity loss.



**Figure 7.** Overview of left side instrument panel and windshield

### MANUAL RESTRAINT SYSTEMS - 2004 Chevrolet 1500

The 2004 Chevrolet was configured with integral 3-point lap and shoulder belts for the front outboard seating positions. The second row outboard seats were configured with manual 3-point lap and shoulder belts. All the outboard seats were equipped with sliding latch plates. The middle seating positions for the first and second row of seats were equipped with manual lap belts. There were no anchorage adjustments available for any seating position.



**Figure 8.** Driver's integral seat belt

## FRONTAL AIR BAG SYSTEM - 2004 Chevrolet 1500

The case vehicle was equipped with advanced, CAC dual stage driver and front right passenger air bags. The driver's air bag was mounted in the steering wheel hub. The deployed driver's air bag was round and measured 62.0 cm (24.4 in). The dual module cover flaps opened in an "I" type configuration. Both flaps measured 6.0 cm (2.4 in) wide by 12.0 cm (4.7 in) high. There were no indications of any damage to driver's air bag or the module cover flaps. The front right passenger air bag was a mid instrument panel mount. The passenger sensing system did not detect a front right passenger and the front right passenger air bag was suppressed and did not deploy.



**Figure 9.** Face of driver's air bag

The case vehicle was equipped with advanced occupant protection systems. The systems consists of the Sensing Diagnostic Module (SDM), dual stage driver and front right passenger air bags with a passenger air bag Off Switch, a front right Passenger Sensing System, 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 SDM will record 100 milliseconds of data after the deployment criteria is met and up to 50 milliseconds of data before deployment criteria is met. For non-deployments the SDM will record the first 150 milliseconds after algorithm enable. The SDM data was downloaded using the Vetronix Crash Data Retrieval System.



**Figure 10.** Driver's air bag module cover

*The Vetronix report indicates that there was both a deployment event and a non deployment event. The deployment event occurred as a result of the impact with the tree. The non deployment event had occurred at some point in the past; 117 ignition cycles had occurred between the time of the non deployment event (2429) and the deployment event (2546).*

Deployment Event

1. The SIR warning lamp status was OFF.
2. The driver's belt switch circuit status was UNBUCKLED.
3. Ignition cycles at deployment were 2546.
4. Ignition cycles at investigation were 2547.
5. Maximum SDM recorded velocity change was -26.60 km/h (-16.53 mph).
6. The time from algorithm enable (AE) to maximum recorded velocity change was 150 milliseconds
7. Driver first stage time algorithm enabled to deployment command criteria met was 5 milliseconds.
8. Driver's second stage time algorithm enable to deployment command criteria met was not applicable.
9. Passenger first stage time algorithm enabled to deployment command was SUPPRESSED.
10. Passenger second stage time algorithm enabled to deployment command was not applicable.
11. The brake switch circuit status was OFF five seconds before AE and went to ON two seconds before AE
12. The vehicle speed was 92 km/h (57 mph) five seconds before AE. Between four and one second before AE the values varied in an inconsistent pattern as compared to the percent of throttle. This is likely due to wheel slippage.

Non Deployment Event

1. The SIR warning lamp status was OFF.
2. The driver's belt switch circuit status was UNBUCKLED.
3. Ignition cycles at deployment were 2429.
4. Ignition cycles at investigation were 2547.
5. Maximum SDM recorded velocity change was -0.16 km/h (-0.10 mph).
6. The time from algorithm enable (AE) to maximum recorded velocity change was 0 milliseconds.
7. The brake switch circuit status was OFF five seconds before AE and remained off throughout the recording.
8. The vehicle speed was 0 throughout the recording.

**OCCUPANT DEMOGRAPHICS - 2004 Chevrolet 1500**

	Driver
Age/Sex:	24/Male
Seated Position:	Front left
Seat Type:	Bench with folding back. Seat adjusted to between middle and forward most track position. Seat back slightly reclined.
Height:	180 cm (71 in)
Weight:	71 kg (157 lbs)
Occupation:	Mechanic, per police report
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	Alcohol involvement. BAC test=0.116 %
Driving Experience:	Unknown
Body Posture:	Normal, upright
Hand Position:	Left hand at 10 o'clock position on steering wheel, right on center console
Foot Position:	Both feet on floor or on foot controls
Restraint Usage:	Integral 3-point manual lap and shoulder belt available, not used
Air bag:	Driver's air bag available, deployed

**OCCUPANT INJURIES - 2004 Chevrolet 1500**

Driver: Injuries obtained from driver interview.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Contusion, right elbow	790402.1,1	Center console	Probable
Contusion, right knee	890402.1,1	Knee bolster	Certain
Abdominal strain	Not codeable	Unknown	Unknown

**OCCUPANT KINEMATICS - 2004 Chevrolet 1500**

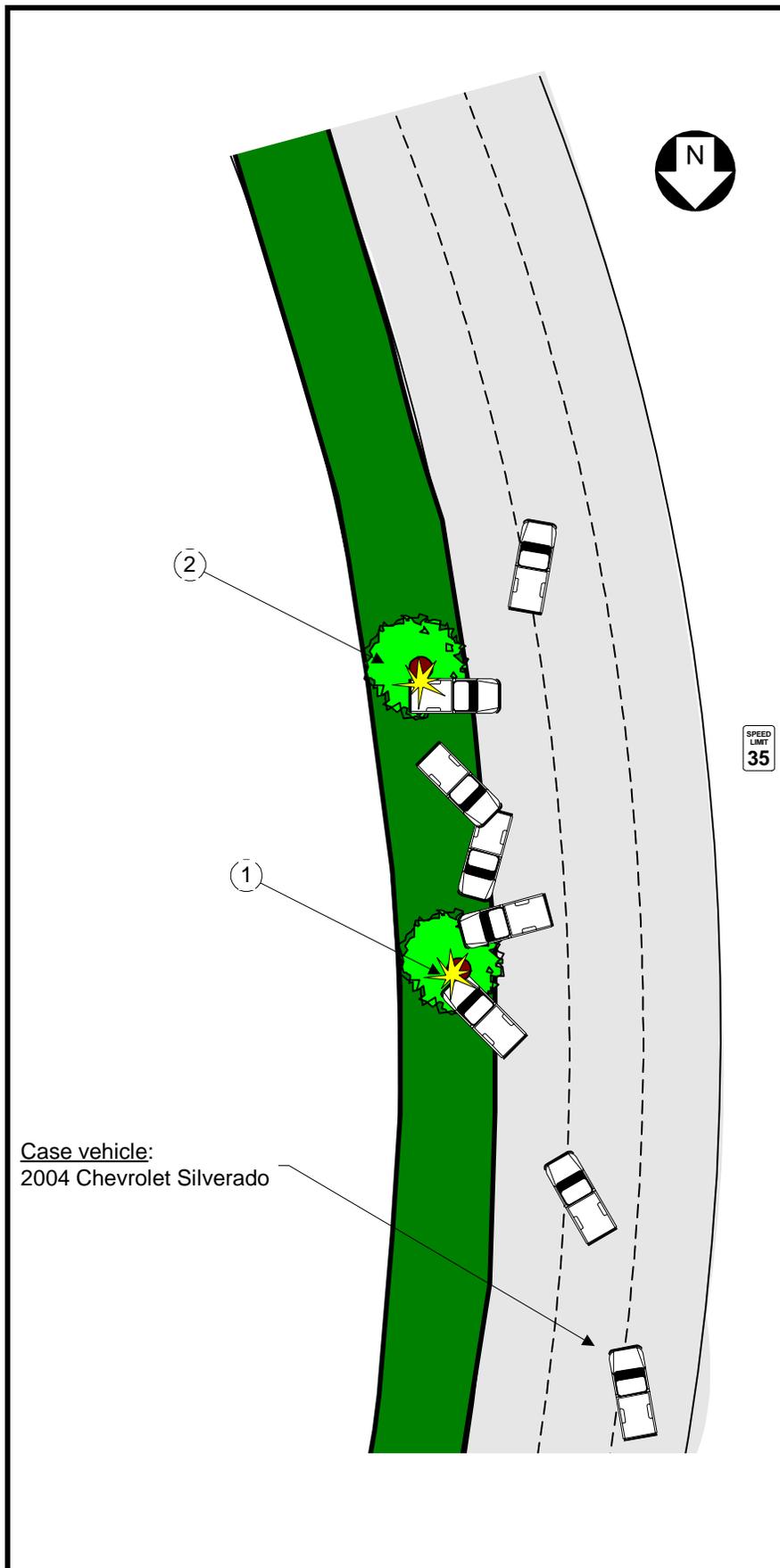
The 24-year-old male driver of the Chevrolet 1500 was seated in a normal, upright position. He was not wearing the available 3-point manual lap and shoulder belt. He was seated on a bench with a folding back. The seat was adjusted to between middle and forward most track position and the seat back was slightly reclined. The steering wheel was adjusted to the center position. The driver's left hand was at the 10 o'clock position on steering wheel; the right hand was on the center console. As the vehicle entered the curve, the driver lost control and the vehicle began a counterclockwise rotation. This motion caused the driver to begin shifting to the right.



**Figure 11.** Contact to center console

As the vehicle jumped the curb and struck the tree, the driver's air bag deployed. The unbelted driver pitched forward and to the right in response to the 1 o'clock direction of force. Both knees contacted the knee bolster, causing a minor contusion to the right knee. His right hip likely caused the center console to shift to the right. The driver did sustain a small contusion to the right elbow that was attributed to the center console. There were also contacts to the visor and windshield. The initial impact with tree exacerbated the vehicle's counterclockwise rotation. This motion kept the driver generally moving to the right as the vehicle continue down the median. The vehicle then struck a second tree with its left corner. This appeared to be a relatively minor impact. The vehicle continued its rotation until coming to rest back on the roadway facing south after rotating approximately 340 degrees. The driver was able to exit the vehicle on his own. He did not receive any medical treatment.

Attachment 1. Scene Diagram



## Attachment 2. EDR Summary

### CDR File Information

Vehicle Identification Number	2GCEC19V141xxxxx
Investigator	
Case Number	2004-50-129G
Investigation Date	Thursday, November 4 2004
Crash Date	
Filename	2004-50-129-V1WITHOUTHVIN.CDR
Saved on	Thursday, November 4 2004 at 09:42:07 AM
Data check information	3E808259
Collected with CDR version	Crash Data Retrieval Tool 2.50
Collecting program verification number	30CAB595
Reported with CDR version	Crash Data Retrieval Tool 2.50
Reporting program verification number	30CAB595
Interface used to collected data	Block number: 00 Interface version: 3F Date: 08-06-04 Checksum: 6700
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 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 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 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 deployments 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-deployments, 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 does not receive a valid message.

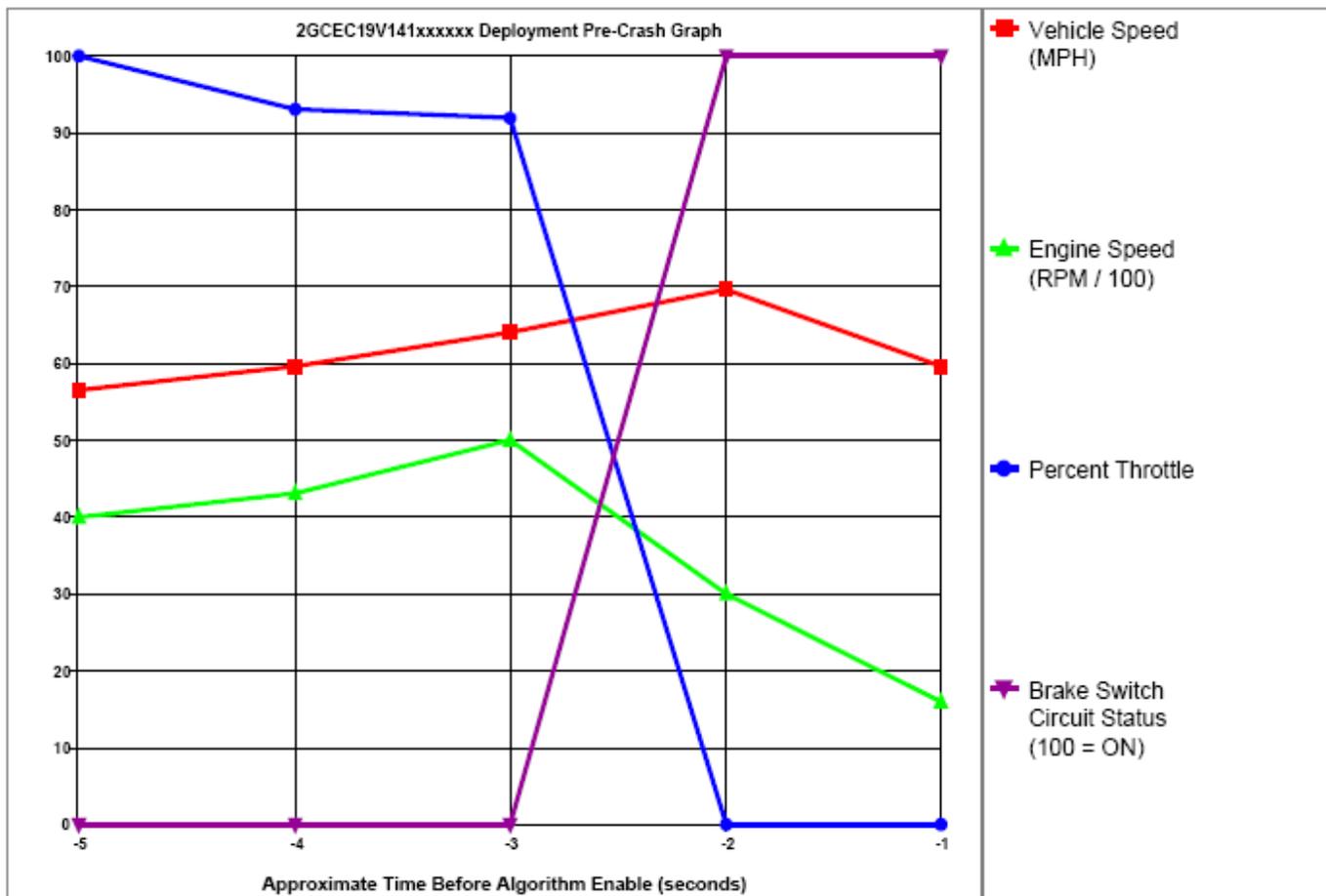
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit

-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.

### System Status At Deployment

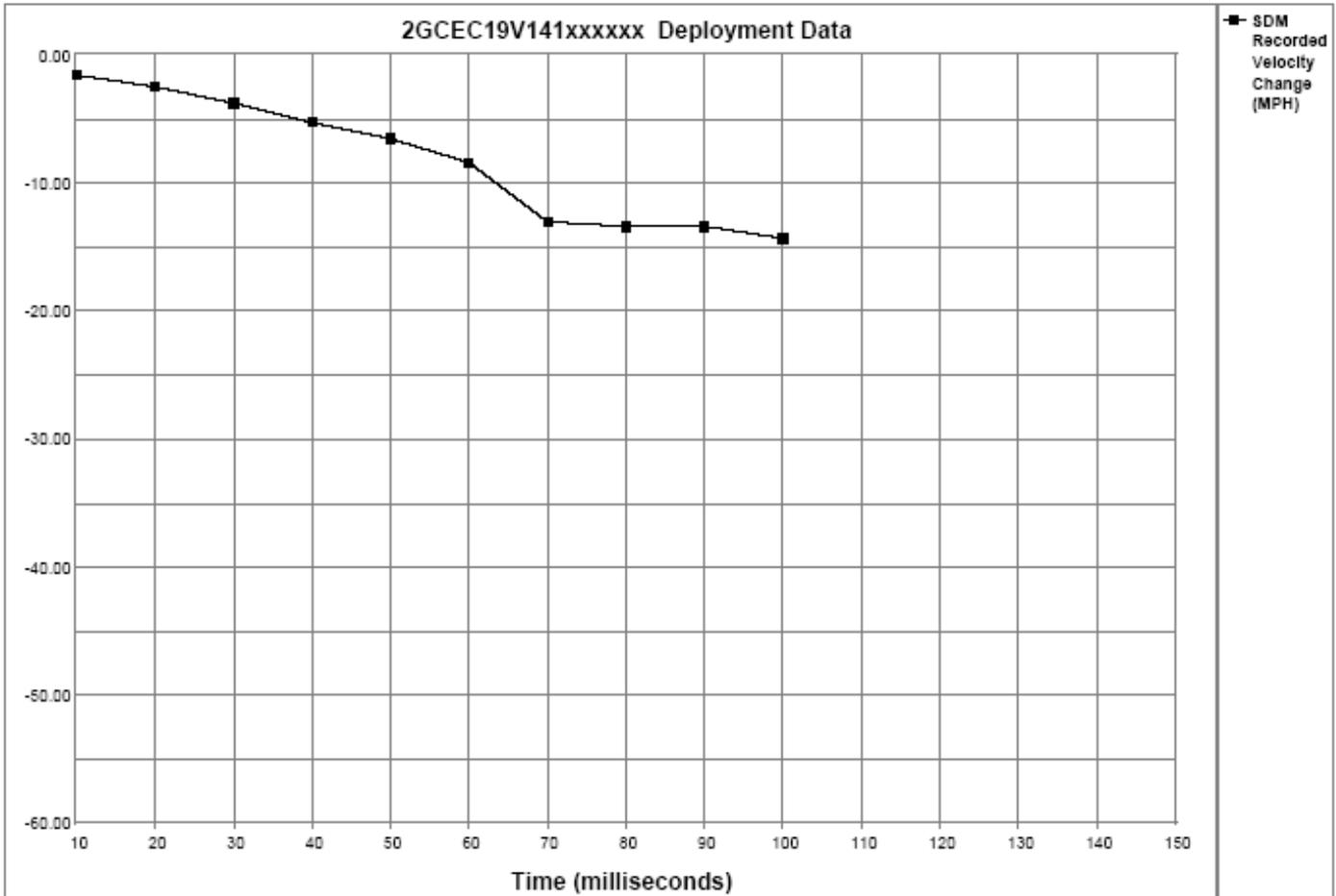
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Deployment	2546
Ignition Cycles At Investigation	2547
Maximum SDM Recorded Velocity Change (MPH)	-16.53
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	150
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	Suppressed
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
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



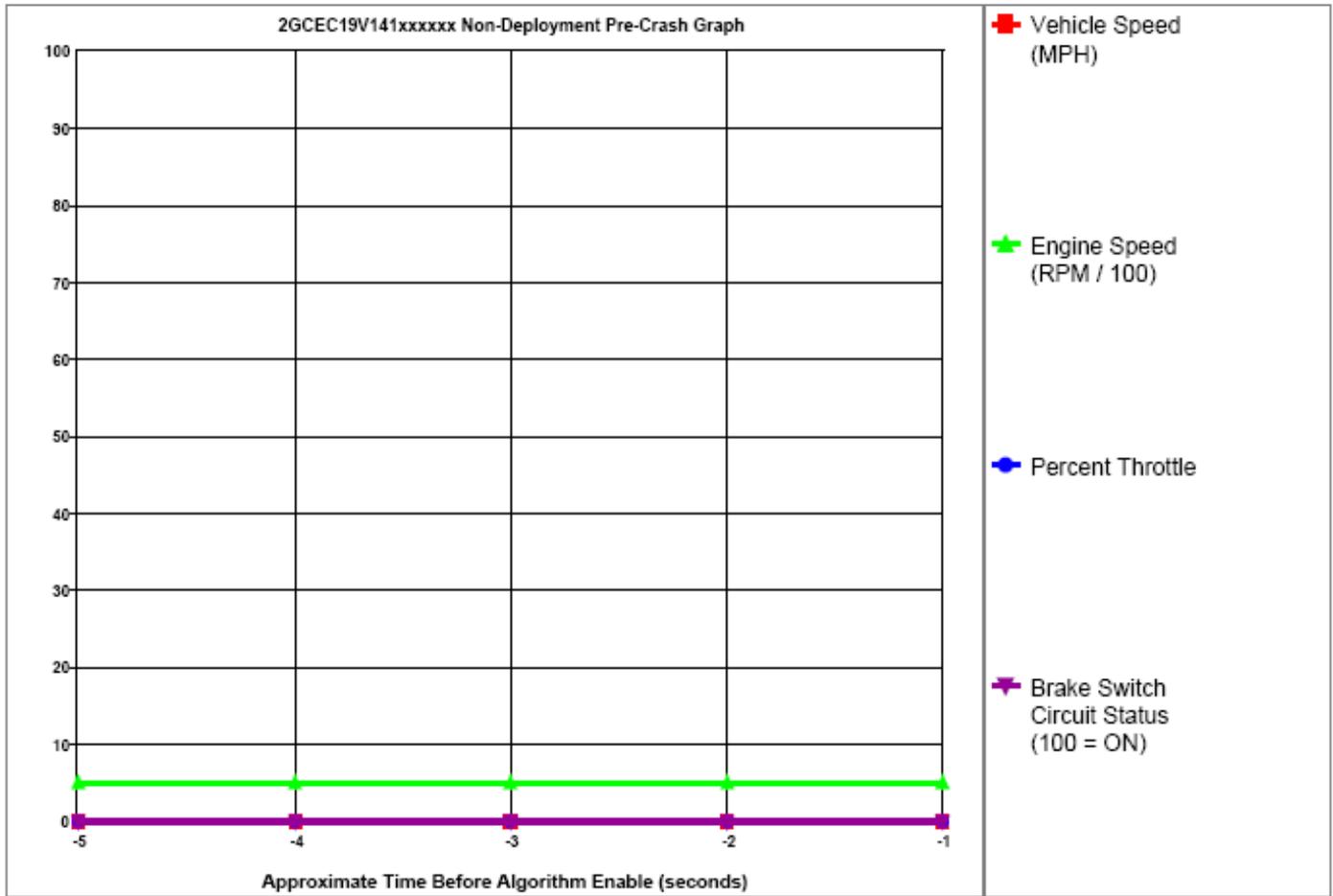
<b>Seconds Before AE</b>	<b>Vehicle Speed (MPH)</b>	<b>Engine Speed (RPM)</b>	<b>Percent Throttle</b>	<b>Brake Switch Circuit Status</b>
-5	57	3968	100	OFF
-4	60	4288	93	OFF
-3	64	4992	92	OFF
-2	70	3008	0	ON
-1	60	1600	0	ON

### System Status At Non-Deployment

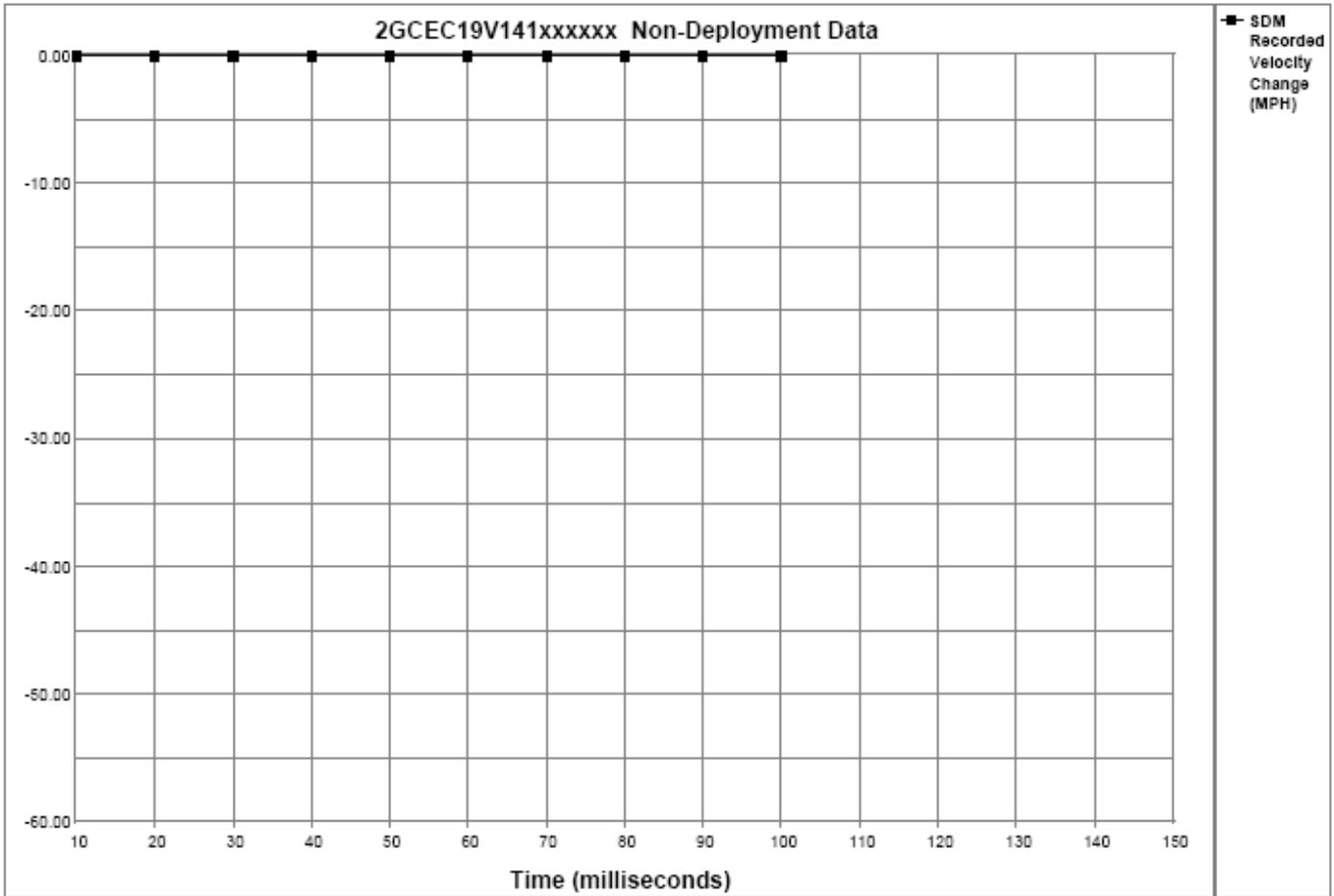
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Non-Deployment	2429
Ignition Cycles At Investigation	2547
Maximum SDM Recorded Velocity Change (MPH)	-0.10
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	0
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-1.55	-2.48	-3.72	-5.27	-6.51	-8.37	-13.02	-13.33	-13.33	-14.26	N/A	N/A	N/A	N/A	N/A



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	0	512	0	OFF
-4	0	512	0	OFF
-3	0	512	0	OFF
-2	0	512	0	OFF
-1	0	512	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	N/A	N/A	N/A	N/A	N/A