

On-Site Certified Advanced 208 Compliant Crash Investigation  
Dynamic Science, Inc. / Case Number: DS03006  
2003 Chevrolet K1500 Silverado extended cab pickup  
Arizona  
January, 2003

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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 <p>The crash occurred in January, 2003 at 1612 hours in Arizona. The crash occurred within the confines of a four-leg intersection. The speed limit for all involved roadways is 80 km/h (50 mph). The case vehicle was a 2003 Chevrolet K1500 Silverado extended cab 4x4 pickup driven by an unrestrained 48-year-old male traveling southbound at a police estimated speed of 64-72 km/h (40-45 mph).</p> <p>The other vehicle was a 1997 Honda Accord four-door sedan driven by a restrained 76-year-old female traveling westbound at a police estimated speed of 64-80 km/h (40-50 mph). It is this investigator's opinion, however, that the driver of the Honda stopped at the intersection first. The driver then attempted to cross the intersection in front of the case vehicle. The Honda accelerated to an estimated speed of 21 km/h (13 mph). The driver of the case vehicle saw the Honda and began braking. The front of the case vehicle (12FYEW1) struck the right side of the Honda (03RYAW2). The driver's air bag in the case vehicle deployed at this time. The passenger's frontal air bag did not deploy. The Honda was pushed in a counterclockwise direction and there was a second, side-slap type impact between the left side of the Chevrolet (09LPEW1) and the right side of the Honda. The Honda departed the intersection in a southwestern direction. The case vehicle rotated in clockwise direction and came to rest in the intersection.</p> <p>The driver of the case vehicle sustained minor abrasions to his left forearm (AIS=1). These were likely as a result of the air bag deployment. He was transported from the scene to a local hospital where he was treated and released. The driver of the other vehicle sustained minor lacerations to her right hand and fingers (AIS=1).</p> <p>Both vehicles were towed from the scene due to damage. The case vehicle was under repair at the time of the inspection.</p>					
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**Dynamic Science, Inc.**  
**Accident Investigation**  
**Case Number: DS03006**

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## BACKGROUND:

Description: This Advanced 208 Compliant case was identified by National Automobile Sampling System (NASS) Zone Center 2. The crash occurred in January, 2003. The case was reported to DSI on February 12, 2003. DSI contacted the repair shop on that same day and learned that the vehicle was already in the process of being torn down for repair. It was determined that police photographs would be available and these were obtained. The case vehicle was inspected and the System Diagnostic Module (SDM) downloaded on February 25, 2003.

Investigation Type:	On-scene
Crash Location:	Arizona
Crash Date:	January, 2003
Notification Date:	February 12, 2003
Field Work Completed:	February 25, 2003

## SUMMARY

### Crash Site

The crash occurred in January, 2003 at 1612 hours in Arizona. The crash occurred within the confines of a four-leg intersection. The southbound leg of the intersection is comprised of one southbound travel lane, one northbound travel lane, and one left hand turn lane. The westbound leg of the intersection is comprised of one westbound travel lane and one eastbound lane. The westbound roadway is controlled by a stop sign and a flashing stop signal. The roadways were clear and free of defects. The asphalt roadways were dry and straight. The speed limit for all involved roadways is 80 km/h (50 mph).



**Figure 1.** Case vehicle approach to area of impact (south)

## Pre-Crash

The case vehicle was a 2003 Chevrolet K1500 Silverado extended cab 4x4 pickup driven by an unrestrained 48-year-old male (86 kg/190 lbs) traveling southbound at a police estimated speed of 64-72 km/h (40-45 mph). Data from the SDM shows the case vehicle to be traveling 92 km/h (57 mph) prior to braking. DSI calculates the pre-braking travel speed to be 93 km/h (58 mph)<sup>1</sup>. The other vehicle was a 1997 Honda Accord four-door sedan driven by a restrained 76-year-old female traveling westbound at a police estimated speed of 64-80 km/h (40-50 mph). It is this investigator's opinion, however, that the driver of the Honda stopped at the intersection first. The driver then attempted to cross the intersection in front of the case vehicle. The Honda accelerated to an estimated speed of 21 km/h (13 mph)<sup>2</sup>. The driver of the case vehicle saw the Honda and began braking.

## Crash

The front of the case vehicle (12FYEW1) struck the right side of the Honda (03RYAW2). The SDM recorded a maximum longitudinal velocity change of -11.29 km/h (-7.02 mph). The total velocity change calculated by the WINSMASH collision model using CDCs only was 14.0 km/h (8.7 mph). The longitudinal and lateral delta V components were -13.8 km/h (-8.6 mph) and 2.4 km/h (1.5 mph), respectively. The driver's air bag in the case vehicle deployed at this time. The passenger's frontal air bag did not deploy. The total velocity change for the other vehicle was 23.0 km/h (14.3 mph). The longitudinal and lateral delta V components were -4.0 km/h (-2.5 mph) and -22.7 km/h (-14.1 mph), respectively.



**Figure 2.** Other vehicle approach to area of impact (west)



**Figure 3.** Final rest, case vehicle (south)

<sup>1</sup>See Attachment 2

<sup>2</sup>Calculated using an acceleration rate of 4 ft/sec/sec

The Honda was pushed in a counterclockwise direction and there was a second, side-slap type impact between the left side of the Chevrolet (09LPEW1) and the right side of the Honda. The Honda departed the intersection in a southwestern direction. The case vehicle rotated in clockwise direction and came to rest in the intersection.

### Post-Crash

The driver of the case vehicle was able to exit the vehicle on his own. He sustained a minor abrasion to the back of the left wrist (AIS=1)--where his watch had been worn. The injury was likely the result of the air bag deployment. He was transported from the scene to a local hospital and arrived at 1705 hours, 53 minutes post-crash. He was treated and then released at 1927 hours.

The driver of the other vehicle sustained minor lacerations to her right hand and fingers (AIS=1). She was treated at the scene by local medical personnel. She refused any additional treatment.

Both vehicles were towed from the scene due to damage. The case vehicle was under repair at the time of the inspection.



Figure 4. Front left, case vehicle. Police photo.



Figure 5. Side slap damage to left rear door panel



Figure 6. Right side, Honda Accord

**VEHICLE DATA - 2003 Chevrolet Silverado****VEHICLE DAMAGE**

Description: 2003 Chevrolet K1500 Silverado extended cab 4x4 pickup. Vehicle equipped with Z71 off-road package. The Z71 Package includes: 46mm shock absorbers, off-road jounce bumpers and stabilizer bars, skid plate package, and a high-capacity air cleaner.

VIN: 2GCEK19T931xxxxxx

Odometer: Unknown

Engine: 5.3L, V8

Reported Defects: None noted

Cargo: Aluminum tool box (unknown weight)

Damage Description: Moderate damage to front bumper, grille, hood from initial impact. Minor crush damage to left rear door. Vehicle towed due to damage.

CDC: Impact 1: 12FYEW1  
Impact 2: 09LPEW1

Delta V (Impact 1)<sup>3</sup>:

Total	14.0 km/h (8.7 mph)
Longitudinal	-13.8 km/h (-8.6 mph)
Latitudinal	2.4 km/h (1.5 mph)
Energy	20,450 joules (15,083 ft lbs)

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<sup>3</sup>WINSMASH collision model using CDCs only



**Figure 7.** Front right, case vehicle

## Air Bag System

This vehicle was equipped with an advanced occupant protection system. The system consists of the SDM, dual stage front air bags, a front right passenger sensing system, and a driver's seat belt latch usage detector. The system is equipped with an air bag shutoff switch for the front right passenger air bag. The switch was set to AUTO at the time of the inspection. The system is controlled by the SDM. The SDM is located beneath the driver's seat. 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.



**Figure 8.** Face of driver's air bag

The downloaded data indicated that the case vehicle had a maximum recorded longitudinal velocity change of -11.29 km/h (-7.02 mph) at the 112 ms mark.

The Vetronix report further indicates that:

1. The driver's belt switch status was unbuckled.
2. The time from algorithm enable (AE) to maximum recorded velocity change was 112.5 milliseconds
3. This was a first stage deployment with the time from AE to deployment command criteria met being 17.5 milliseconds.
4. There was no second stage deployment.
5. The brake switch status was ON two seconds before algorithm enable.
6. The vehicle speed was 92 km/h (57 mph) five seconds before AE, decelerating to 72 km/h (45 mph) one second before AE.



**Figure 9.** Driver's seat

The case vehicle was equipped with frontal air bags mounted in the steering wheel and mid mounted in the instrument panel of the front right seat position. The driver's air bag deployed. With an unrestrained driver, the deployment threshold would necessarily be lower. The passenger air bag did not deploy. The driver's air bag module had been removed from the vehicle. The driver air bag module was located in the center hub of the steering wheel rim. The air bag module cover had an I-configuration. It was equipped with one tether and had two vent ports (11 and 1 o'clock positions). There was no contact evidence on the face of the air bag.

### Manual Restraint System

The 3-point manual restraint systems were integrated into the driver and front passenger seats. The restraint system for the rear bench seat consisted of 3-point lap and shoulder belts with fixed D-rings for the outboard positions and a center lap belt. There was no indication of seat belt usage.



**Figure 10.** Close up of driver's seat belt



**Figure 11.** Passenger air bag cut off switch in AUTO position

**VEHICLE DATA - 1997 Honda Accord**

Description:	1997 Honda Accord LX four-door	
VIN:	1HGCD5630VAxxxxxx	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Police report describes vehicle as being disabled. Vehicle towed due to damage. Damage described as heavy contact to its right side; damage to right front fender, right front wheel, right side mirror, right front door, and right rear fender. Windshield damaged.	
CDC:	Impact 1: 03RYAW2 Impact 2: Unknown	
Delta V (Impact 1):	Total	23.0 km/h (14.3 mph)
	Longitudinal	-4.0 km/h (-2.5 mph)
	Latitudinal	-22.7 km/h (-14.1 mph)
	Energy	22,788 joules (16,808 ft lbs)



**Figure 12.** Right side, Honda. Police photo.

**OCCUPANT DEMOGRAPHICS**

<u>2003 Chevrolet Silverado</u>	Occupant 1
Age/Sex:	48/Male
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat, unknown seat track position (seat removed prior to inspection)
Height:	Unknown
Weight:	86 kg (190 lbs)
Occupation:	Driver
Pre-existing Medical Condition:	High blood pressure
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be greater than 10 year
Body Posture:	Presumed to be normal, upright
Hand Position:	Left hand on steering wheel, right unknown
Foot Position:	Right foot on brake, left on floor
Restraint Usage:	Integrated lap and shoulder belt, <u>not</u> used
Air bag:	Steering wheel mounted air bag, deployed

1997 Honda Accord

Age/Sex:	76/Female
Seated Position:	Front left
Seat Type:	Bucket
Height:	Unknown
Weight:	Unknown
Occupation:	Presumed to be retired
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be greater than 10 years
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Right foot presumed to be on accelerator, left on floor
Restraint Usage:	Lap and shoulder belt available, used – per police report

**OCCUPANT INJURIES**

2003 Chevrolet Silverado

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Abrasion, left wrist	790202.1,2	913.0	Air bag

1997 Honda Accord

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Minor lacerations, right hand	790600.1,1	882.0	Unknown
	Minor lacerations, right fingers	790600.1,1	883.0	Unknown

## OCCUPANT KINEMATICS

The 48-year-old driver of the case vehicle was seated in a normal, upright fashion in the fabric covered bucket seat. The seat had been removed prior to inspection and the seat track position is not known. He was not wearing the available 3-point integrated lap and shoulder belt. There were no indications of usage in this crash. The SDM indicated the seat belt was unbuckled. Prior to impact, his right foot was on the brake; the left was on the floor. Both hands were on the steering wheel.

Upon impact, the driver's front air bag deployed. The driver responded to the 12 o'clock direction of force by exhibiting a forward trajectory. His head and torso likely loaded the deployed air bag to some degree. The driver's left wrist/watch came into contact with the deploying air bag—causing a minor abrasion. During the second impact, the driver pitched to the left to some slight degree. There were no indications of interior contacts or any resultant injuries. He was transported by a ground ambulance to a local trauma center where he was examined and released at 1927 hours. The transport was mainly due to his elevated blood pressure.



**Figure 13.** Overview of driver's seated area

Attachment 1. Scene Diagram

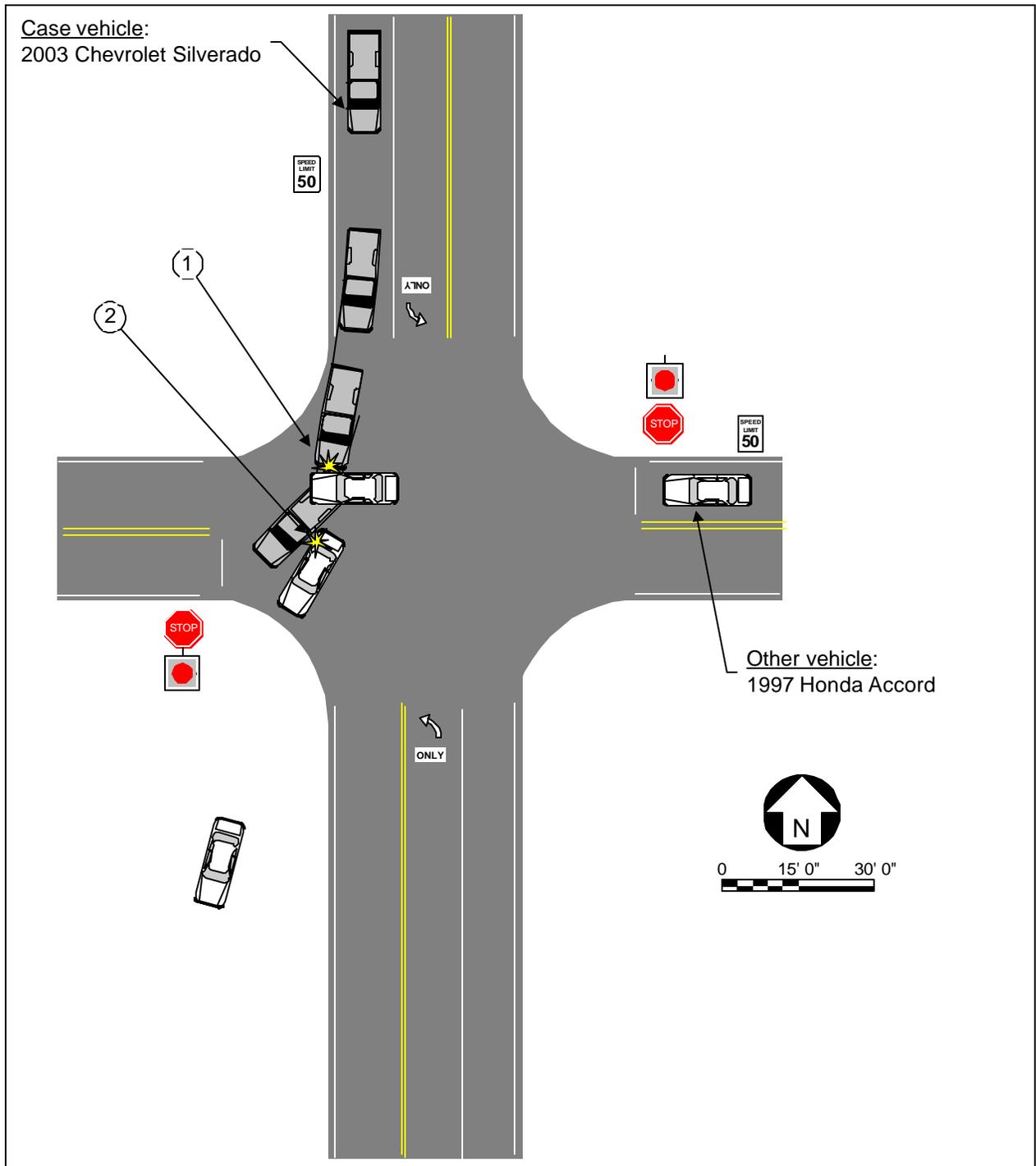


Figure 14. Scene diagram

Attachment 2. Calculations

**CASE NUMBER: DS03006**

Comments: Other vehicle - accelerate from stop

**\*\* VELOCITY AT ANY POINT IN A SKID/ACCEL \*\***

$V = \sqrt{Vo^2 \pm (2 \times a \times D)}$

$V = \sqrt{0.00^2 + (2 \times 4.00 \times 46.00)}$

$V = \sqrt{0.00 + 368.00}$

$V = \sqrt{368.00}$

V = 19.18

V = The Velocity in FPS.  
 Vo = The Original Velocity in FPS.  
 2 = A Constant.  
 a = The Acceleration Rate.  
 D = The Distance in Feet.

INPUTS:		RESULTS:	
The Acceleration Rate is:	4.00	The Speed in MPH is:	13.08
The Velocity in FPS is:	0.00	The Velocity in FPS is:	19.18
The Distance in Feet is:	46.00		

AR Pro, Ver. 7.06: © Since 1994, Maine Computer Group.

**CASE NUMBER: ds03006**

Comments: speed assuming brakes on for 2 seconds (83 fps 1st second, 65 fps 2nd second)

**\*\* MINIMUM SPEED W/ KNOWN DRAG FACTOR \*\***

$$S = \sqrt{30 \times D \times f}$$

$$S = \sqrt{30 \times 148.00 \times 0.65}$$

$$S = \sqrt{2886.00}$$

$$S = 53.72$$

S = The Speed in MPH.  
 30 = A Constant.  
 D = The Distance in Feet.  
 f = The Adjusted Accel/Drag Factor.

INPUTS:		RESULTS:	
The Acceleration/Drag Factor is:	0.65	The Speed in MPH is:	53.72
The Distance in Feet is:	148.00	The Velocity in FPS is:	78.75

**CASE NUMBER: ds03006**

Comments: post impact skid

**\*\* MINIMUM SPEED W/ KNOWN DRAG FACTOR \*\***

$$S = \sqrt{30 \times D \times f}$$

$$S = \sqrt{30 \times 22.00 \times 0.65}$$

$$S = \sqrt{429.00}$$

$$S = 20.71$$

S = The Speed in MPH.

30 = A Constant.

D = The Distance in Feet.

f = The Adjusted Accel/Drag Factor.

INPUTS:	
The Acceleration/Drag Factor is:	0.65
The Distance in Feet is:	22.00

RESULTS:	
The Speed in MPH is:	20.71
The Velocity in FPS is:	30.36

**CASE NUMBER: DS03006**

Comments: combined speeds (pre-impact braking, post impact skid, delta v)

**\*\* COMBINED MINIMUM SPEEDS W/ KNOWN SPEEDS \*\***

$$S = \sqrt{S^2(1) + S^2(2) + \dots S^2(n)}$$

$$S = \sqrt{(53.72)^2 + (20.71)^2 + (7.02)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2 + (0.00)^2}$$

$$S = \sqrt{2885.83 + 428.90 + 49.28 + 0.00 + 0.00 + 0.00 + 0.00 + 0.00}$$

$$S = \sqrt{3364.01}$$

$$S = 58.00$$

S = The Speed in MPH.  
 S<sup>2</sup> = The Individual Min. Speed.  
 (1), (2), (n) = The # of the individual speed.

INPUTS:	
Speed #1 in MPH is:	53.72
Speed #2 in MPH is:	20.71
Speed #3 in MPH is:	7.02

RESULTS:	
The Speed in MPH is:	58.00
The Velocity in FPS is:	85.02

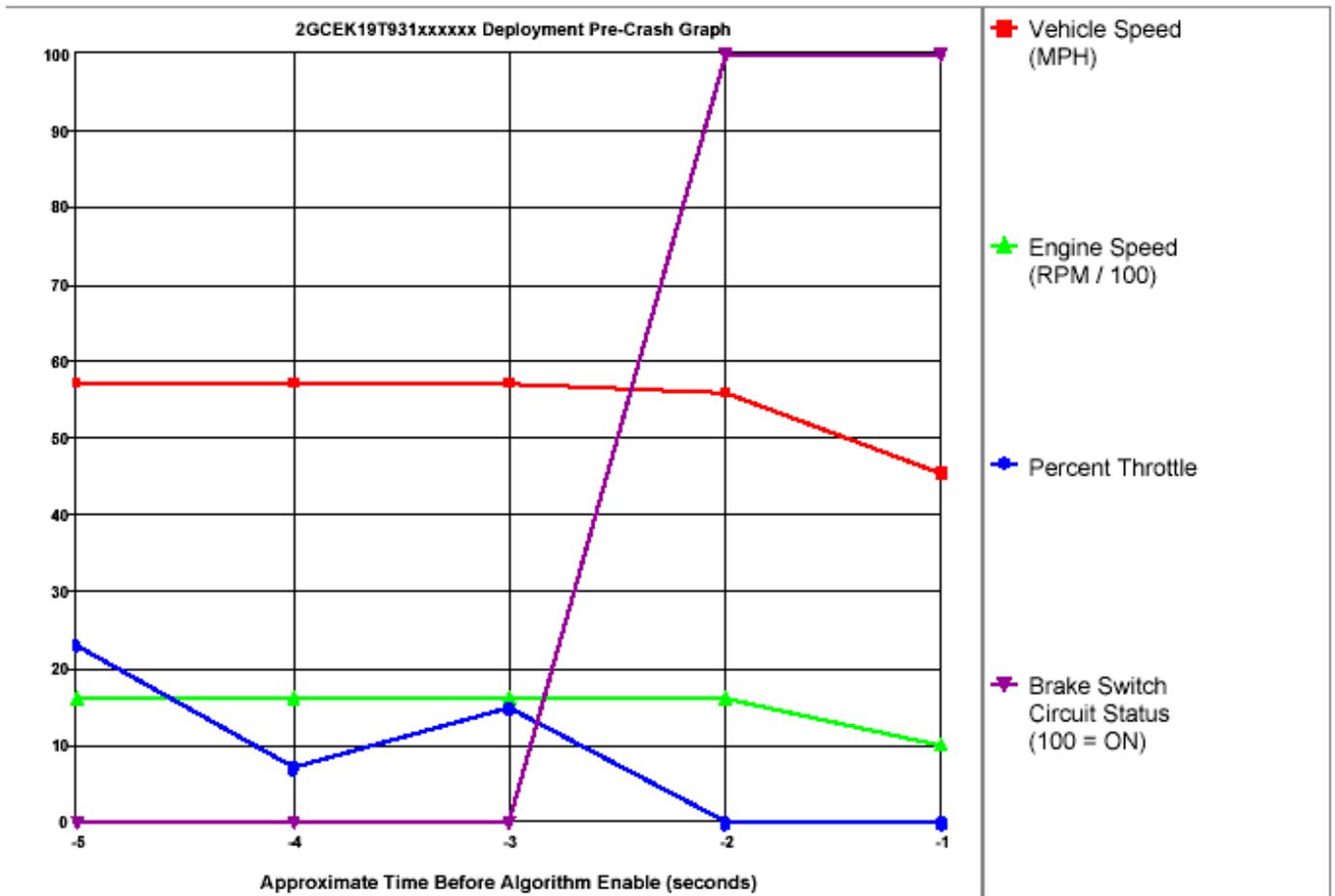
## Attachment 3. Vetronix output

**CDR File Information**

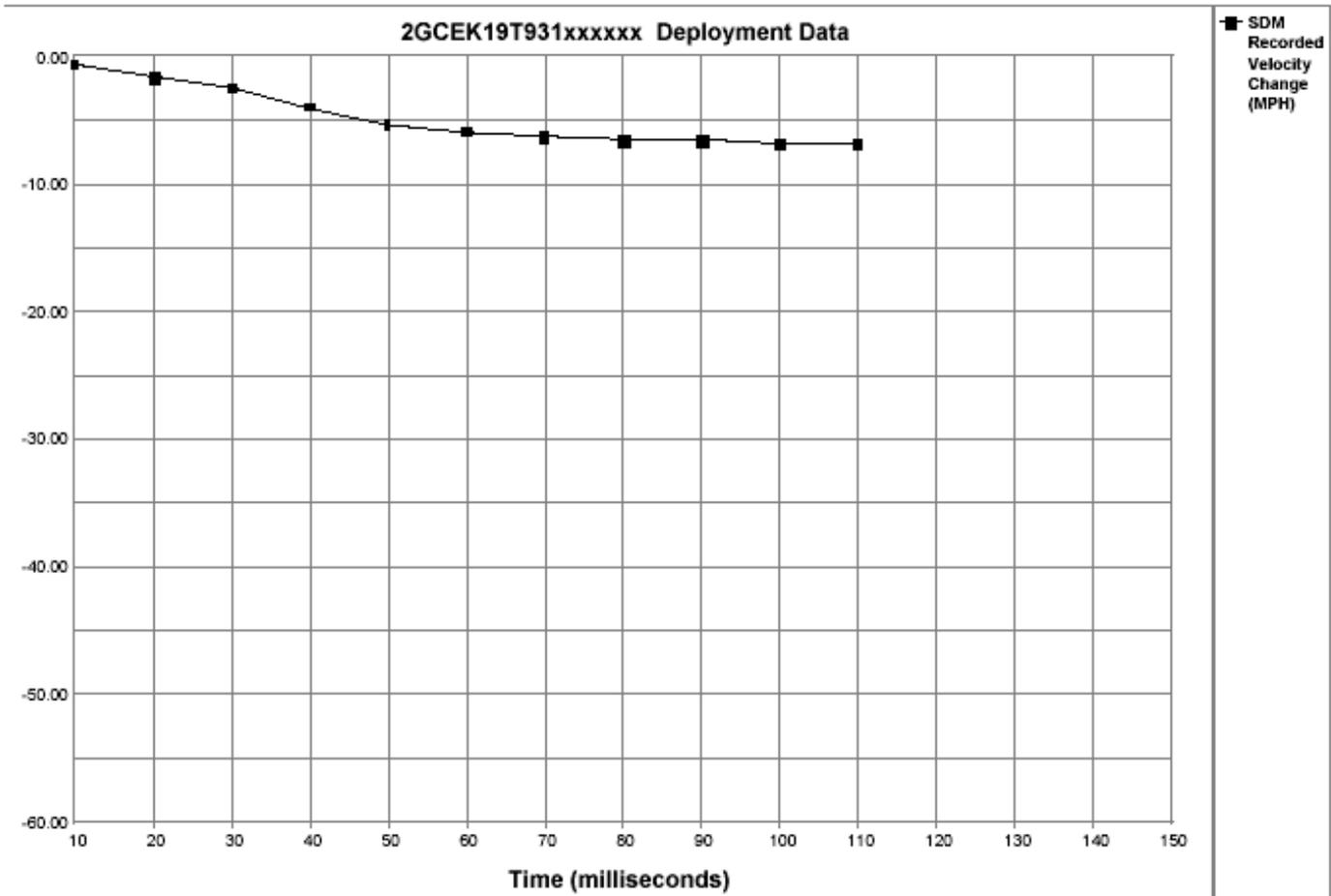
Vehicle Identification Number	2GCEK19T931xxxxxx
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	DS03006.CDR
Saved on	02/25/2003 8:12:53 AM
Data check information	F316BD0F
Collected with CDR version	Crash Data Retrieval Tool 2.00
Collecting program verification number	A31D1C76
Reported with CDR version	Crash Data Retrieval Tool 2.00
Reporting program verification number	A31D1C76
Event(s) recovered	Deployment

**System Status At Deployment**

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Deployment	1714
Ignition Cycles At Investigation	1719
Maximum SDM Recorded Velocity Change (MPH)	-7.02
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	112.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	17.5
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)	N/A
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



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	57	1600	23	OFF
-4	57	1600	7	OFF
-3	57	1600	15	OFF
-2	56	1600	0	ON
-1	45	1024	0	ON



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.62	-1.55	-2.48	-4.03	-5.27	-5.89	-6.20	-6.51	-6.51	-6.82	-6.82	N/A	N/A	N/A	N/A