Certified Advanced 208 Compliant Investigation/ Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS03021
2003 Chevrolet Silverado pickup
Texas
May, 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

This two vehicle, angle-broadside type crash occurred in May, 2003 at 1300 hours in the state of Texas. The crash occurred within the confines of a four-leg intersection. The case vehicle was a 2003 Chevrolet 1500 Silverado pickup that was driven by an unrestrained 20-year-old male. The other vehicle was a 1999 Toyota Camry LE four-door that was being driven by a restrained 51-year-old female. The case vehicle was traveling northbound in the left lane approaching the intersection. The other vehicle was traveling westbound in the left lane and approaching the same intersection. The other vehicle stopped at the intersection and then proceeded to cross through the intersection. The driver of the case vehicle failed to stop at the intersection. The front of the case vehicle struck the left front fender of the other vehicle. The driver's air bag in the Chevrolet deployed at this time. Both vehicles came to rest in the intersection. The police report indicates that the drivers of both vehicles sustained "C" type injuries. Both drivers refused an ambulance and were not transported from the scene for medical treatment. It is not known if they sought treatment for their injuries at a later time. The case vehicle was towed from the scene due to damage and was eventually repaired. The other vehicle was towed from the scene due to damage and was declared a total loss by the insurance company.

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Dynamic Science, Inc.
Crash Investigation
Case Number:DS03021

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BACKGROUND:

Description:

Figure 1. Case vehicle frontal damage

This on-site investigation focused on the performance of the Certified Advanced 208-Compliant air bag system in a 2003 Chevrolet Silverado pickup. The multi-stage air bags were certified by the manufacturer to meet the advanced air bag requirement of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. This two vehicle, angle-broadside type crash occurred in May, 2003 at 1300 hours in the state of Texas. The crash occurred within the confines of a four-leg intersection. The case vehicle was a 2003 Chevrolet 1500 Silverado pickup that was driven by an unrestrained 20-year-old male. The other vehicle was a 1999 Toyota Camry LE four-door that was being driven by a restrained 51-year-old female. The case vehicle was traveling northbound in the left lane approaching the intersection. The other vehicle was traveling westbound in the left lane and approaching the same intersection. The other vehicle stopped at the intersection and then proceeded to cross through the intersection. The driver of the case vehicle failed to stop at the intersection. The front of the case vehicle struck the left front fender of the other vehicle. The driver's air bag in the Chevrolet deployed at this time. Both vehicles came to rest in the intersection. The police report indicates that the drivers of both vehicles sustained "C" type injuries. Both drivers refused an ambulance and were not transported from the scene for medical treatment. It is not known if they sought treatment for their injuries at a later time. The case vehicle was towed from the scene due to damage and was eventually repaired. The other vehicle was towed from the scene due to damage and was declared a total loss by the insurance company.

This 208 Compliant case was initially identified by a NHTSA review of GES police reports. The police report was forwarded to DSI on May 28, with instructions to locate the case vehicle for an on-scene investigation. Permission was obtained and the case was assigned to DSI on June 2, 2003. An on-site investigation was conducted. The data from the Sensing Diagnostic Module (SDM) was downloaded from the case vehicle and all field work was completed on June 3, 2003.

SUMMARY

Crash Site

This two vehicle, angle-broadside type crash occurred in May, 2003 at 1300 hours. The crash occurred within the confines of a four-leg intersection. The northern leg of the intersection is comprised of two northbound through lanes, a left hand turn lane, and two southbound through lanes. Northbound travel lane had a negative 6.1% grade 30.5 meters (100 ft) pre-impact. The western leg of the intersection is comprised of two westbound one-way lanes, with the left lane available for left turns or for through travel and the right lane available for right turns or for through travel. The weather was clear, it was daylight hours and the concrete roadways were dry. The intersection is controlled by standard stop. The posted speed limit is 56 km/h (35 mph) for all roadways.

Figure 2. Case vehicle–approach to impact (north)

Figure 3. Other vehicle–approach to impact (west)

Pre-Crash

The case vehicle is a 2003 Chevrolet 1500 Silverado Z71 4WD extended cab pickup that was driven by an unrestrained 20-year-old male. Inspection of the driver's continuous loop 3-point seat integrated lap and shoulder belt indicated historical usage, but no evidence of loading. The data from the downloaded SDM indicated that the driver's belt switch circuit status as UNBUCKLED. The driver was seated in a cloth covered bucket seat that was adjusted to the rear most seat track position. The seat back was slightly reclined rearward.

The other vehicle is a 1999 Toyota Camry LE four-door that was being driven by a restrained 51-year-old female.

The case vehicle was traveling northbound in the left lane approaching the intersection. The other vehicle was traveling westbound in the left lane and approaching the same intersection. The other vehicle stopped at the intersection and then proceeded to cross through the intersection.

Crash

The driver of the case vehicle failed to stop at the intersection. The front (01FZEW1) of the case vehicle struck the left front fender (10LFEW3) of the other vehicle.

The total velocity change calculated by the missing vehicle algorithm of the WinSmash collision model was 15.0 km/h (9.3 mph)[1]. The longitudinal and lateral delta V components were -14.1 km/h (-8.8 mph) and -5.1 km/h (-3.2 mph), respectively. The results fit the collision model and appear reasonable.

The SDM recorded a velocity change of -12.18 km/h (-7.57 mph) at the 180 millisecond mark.

The driver's air bag deployed at impact with the other vehicle.

Post-Crash

The front right passenger air bag did not deploy due to case vehicle being equipped with a Passenger Sensing System, and the absence of a front right occupant.

The other vehicle is equipped with a driver's and front right passenger's air bag. Neither air bags deployed on impact.

The case vehicle was towed from the scene due to damage and was eventually repaired. The other vehicle was towed from the scene due to damage and was declared a total loss by the insurance company.

The police report indicates that the drivers of both vehicles sustained "C" type injuries. Both drivers refused an ambulance and were not transported from the scene for medical treatment. It is not known if they sought treatment for their injuries at a later time.

[1]Calculated using stiffness values derived from NCAP test 4472

VEHICLE DATA - 2003 Chevrolet Silverado pickup

The 2003 Chevrolet Silverado Z71 4WD extended cab pickup was identified by the Vehicle Identification Number (VIN): 1GCEK19T63Zxxxxxx. The 2003 Chevrolet Silverado pickup was equipped with an eight cylinder 5.3 liter engine, a four speed automatic transmission, four-wheel drive, four wheel disc brakes with ABS, power steering, and a tilt steering wheel. The odometer was 12,218 km (7,592 miles) at the time of the inspection

The 2003 Chevrolet Silverado pickup was equipped with Nitto Terra Grappler All Terrain LT325/60R16 tires. The vehicle recommended cold tire pressure was 241 kPa (35 psi). The specific tire data is as follows:

Tire	Tread	Measured pressure	Tire manufacturer maximum pressure
LF	11 mm (14/32 in)	283 kPa (41 psi)	345 kPa (50 psi)
LR	10 mm (12/32 in)	276 kPa (40 psi)	345 kPa (50 psi)
RR	10 mm (12/32 in)	262 kPa (38 psi)	345 kPa (50 psi)
RF	11 mm (14/32 in)	Flat	345 kPa (50 psi)

The interior of the case vehicle consisted of a five passenger seating configuration. The front row was comprised of two cloth covered reclining bucket seats. A 2nd row comprised of a cloth covered bench seat with folding back (seats three). The driver was seated in a cloth covered bench seat that was adjusted to rear most seat track position with the seat back slightly reclined aft of vertical.

VEHICLE DAMAGE

Exterior Damage - 2003 Chevrolet Silverado pickup

The 2003 Chevrolet Silverado pickup sustained moderate front end damage. The direct contact damage that began at the front right bumper corner and extended laterally 60.0 cm (23.6 in) to the left. Maximum crush measured 20.5 cm (8.1 in) at C6.

CDC:	01FZEW1	
Delta V:	Total	15.0 km/h (9.3 mph)
	Longitudinal	-14.1 km/h (-8.8 mph)
	Latitudinal	-5.1 km/h (-3.2 mph)
	Energy	19,668 joules (14,506 ft lbs)

Interior Damage - 2003 Chevrolet Silverado pickup

The 2003 Chevrolet Silverado pick did not sustain any significant interior damage. Both doors remained closed and operational. There was no glazing damage. There was no intrusion or integrity loss.

MANUAL RESTRAINT SYSTEMS - 2003 Chevrolet Silverado pickup

The driver’s manual restraint system consisted of a seat integrated 3-point manual lap and shoulder safety belt with a sliding latch plate. The emergency locking retractor (ELR) was located in the seat back. The deployment event recorded by SDM reports that the driver’s belt switch circuit status was "UNBUCKLED". The front right seat also consisted of a integrated 3-point manual lap and shoulder safety belt with a sliding latch plate. The seat belt was configured with a switchable automatic locking retractor (ALR)/ELR. The second row outboard seats were equipped with 3-point manual lap and shoulder safety belts with sliding latch plates and switchable retractors. The middle seat was equipped with a manual lap belt.

FRONTAL AIR BAG SYSTEM - 2003 Chevrolet Silverado pickup

The driver's air bag deployed at impact with the other vehicle. The driver's air bag module was located in the center hub of the steering wheel rim and had two module cover flaps. The flaps opened in a designed I-configuration. Both module cover flaps measured 6.0 cm (2.4 in) by 12.0 cm (4.7 in). There was no contact evidence on the cover flaps. The diameter of the driver's air bag measured 66.0 cm (26.0 in) in its deflated state. The driver's air bag had a maximum excursion of 25.0 cm (9.8 in). It had two vent ports at the 11 and 1 o'clock positions and two tethers. There were 12 vertical folds and 9 horizontal folds on the face of the air bag. There were no indications of occupant contact. The front right passenger air bag was a mid-mount design located in the right aspect of the instrument panel. The front right passenger air bag includes a "Passenger Sensing System". The system is designed to automatically switch the air bag on or off based on a passenger's weight. The system also uses a sensor in the passenger-side seat belt to measure how much tension is exerted by the seat belt when it is being cinched down, to assist in determining what may be on the seat.

Figure 5. Case vehicle driver's air bag

Figure 4. Front right Passenger Sensing System

There is an indicator on the rear-view mirror that alerts vehicle occupants to the status of the system at all times. If the light reads "Passenger Air Bag ON," the air bag is programmed to deploy in a frontal crash of sufficient severity. If it reads "Passenger Air Bag OFF," the system has turned off the air bag because it determined either that there is no occupant on the front passenger seat, or that a rear-facing infant seat, a forward-facing child restraint, a booster seat or a smaller person, such as a child who has outgrown child restraints, is present.

The front right passenger air bag also includes a passenger air bag suppression switch mounted in the center instrument panel. The switch has two positions, air bag OFF and AUTO. The switch was switched to the AUTO position.

The front right passenger air bag did not deploy due to case vehicle being equipped with a Passenger Sensing System, and the absence of a front right occupant. The other vehicle is

equipped with a driver's and front right passenger's air bag. Neither air bags deployed on impact.

This vehicle was equipped with an advanced occupant protection system. The system consists of the SDM, dual-level (dual stage) driver and front right passenger air bags, 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. The SDM will also record 150 milliseconds of data after non-deployment criteria is met.

Two events were recorded by the SDM, a Deployment event at 522 ignition cycles and a non-deployment event at 292 ignition cycles. The non-deployment event was not related to this crash.

The Vetronix system status at deployment report indicates that:

1. SIR warning lamp status was OFF.
2. The driver's belt switch status was UNBUCKLED.
3. Ignition cycles at deployment 522.
4. Ignition cycles at investigation 525.
5. Maximum SDM recorded velocity change -12.18 km/h (-7.57 mph).
6. Algorithm enable (AE) to maximum SDM recorded velocity change was 180 milliseconds.
7. Driver first stage time algorithm enabled to deployment command criteria met 37.5 milliseconds.
8. Driver second stage time algorithm enabled to deployment command criteria met N/A.
9. Passenger first stage time algorithm enabled to deployment command criteria met N/A.
10. Passenger second stage time algorithm enabled to deployment command criteria met N/A.
11. Time between non-deployment and deployment events N/A.
12. Frontal deployment level event counter 1.
13. Event recording complete YES.
14. Multiple events associated with this record NO.
15. One or more associated events not recorded NO.
16. The vehicle speed was 55 km/h (34 mph) five seconds before AE, accelerated to 56 km/h (35 mph) at 4 through 3 seconds before AE, 58 km/h (36 mph) at 2 seconds before AE, and decelerated to 55 km/h (34 mph) at 1 second before AE.
17. The brake switch status was OFF from 5 through 2 before AE, and was ON 1 second before AE.

VEHICLE DATA - 1999 Toyota Camry

Description:	1999 Toyota Camry four door sedan	
VIN:	4TIBG22K9XUxxxxxx	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Left front fender	
Delta V:	Total	22.0 km/h (13.7 mph)
	Longitudinal	-7.5 km/h (-4.7 mph)
	Latitudinal	20.7 km/h (12.8 mph)
	Energy	33,962 joules (25,049 ft lbs)

Figure 6. Other vehicle left fender damage

OCCUPANT DEMOGRAPHICS - 2003 Chevrolet Silverado pickup

	Driver
Age/Sex:	20/Male
Seated Position:	Front left
Seat Type:	Cloth covered bucket seat. Adjusted to the rear most seat track position. The seat back was slightly reclined rearward.
Height:	Unknown
Weight:	Unknown
Occupation:	Construction worker
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Right foot likely on brake
Restraint Usage:	Lap and shoulder belt available, not used
Air bag:	Steering wheel mounted air bag, deployed

OCCUPANT DEMOGRAPHICS - 1999 Toyota Camry

Age/Sex:	51/Female
Seated Position:	Front left
Seat Type:	Bucket seat
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, used

OCCUPANT INJURIES - 2003 Chevrolet Silverado pickup

There were no reported injuries by any parties.

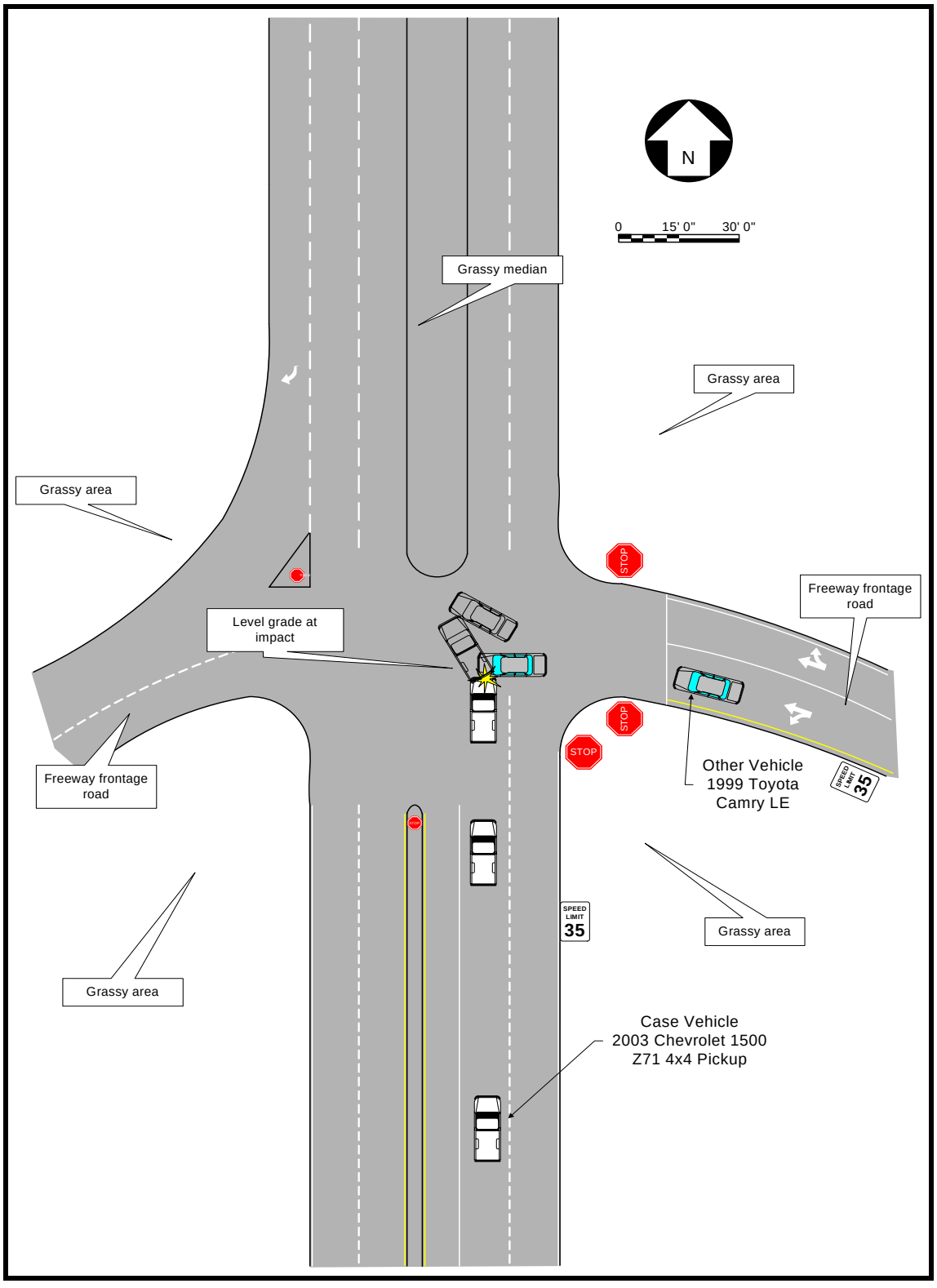
OCCUPANT KINEMATICS - 2003 Chevrolet Silverado pickup

Driver kinematics

The 20-year-old driver was an upright posture. The manual lap and shoulder belt was not being used. The cloth covered bucket seat was adjusted to the rear most track position. The seat back was slightly reclined rearward. The driver's hand locations are not known. Just prior to impact, he was braking. At impact, the driver's air bag deployed. The driver initiated a forward and slightly right trajectory. He likely engaged the deployed air bag in some fashion, but there were no witness marks on the air bag and no reported injuries.

Figure 7. Driver's seated position

Attachment 1. Scene Diagram



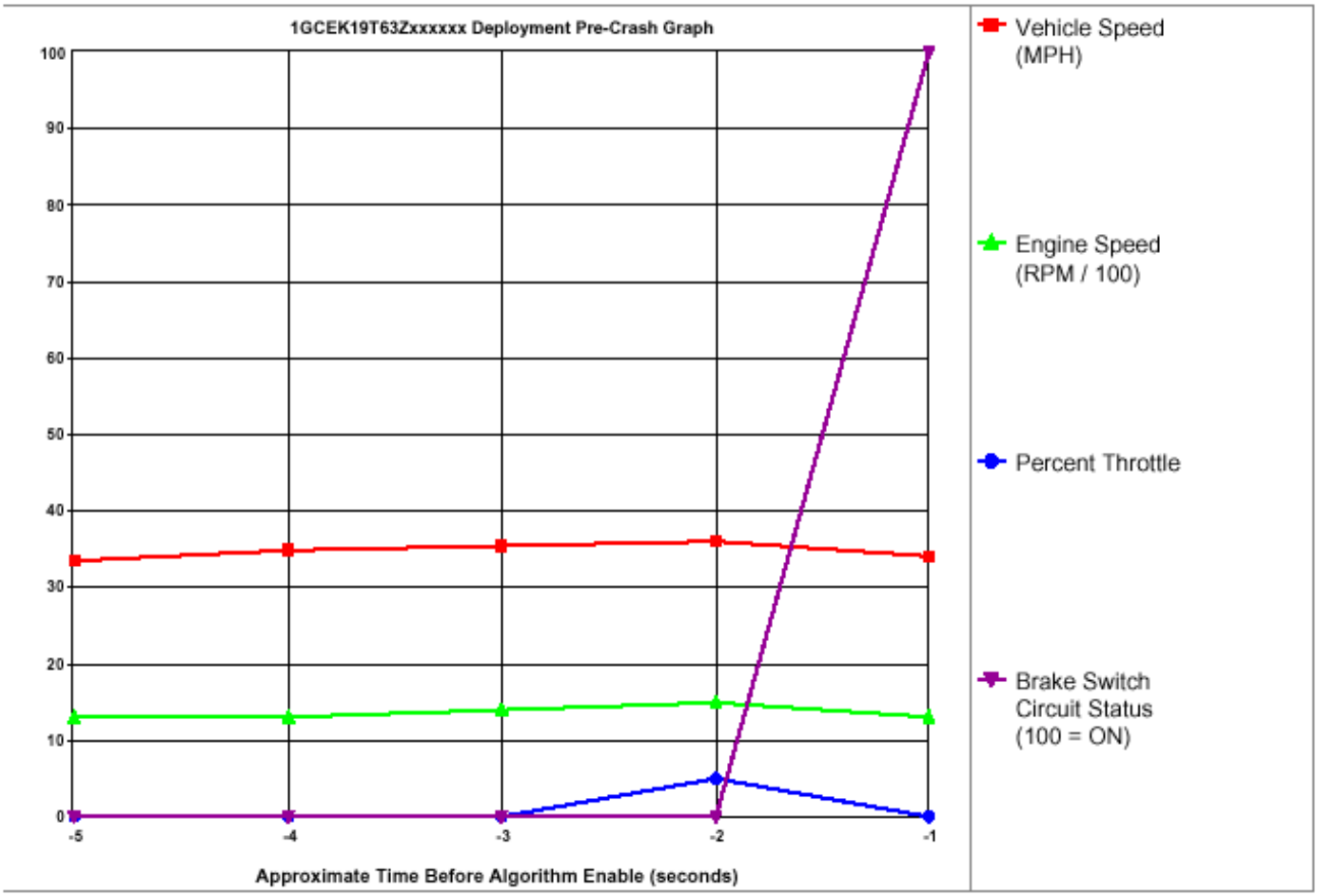
Attachment 2. Vetronix Report

Vetronix

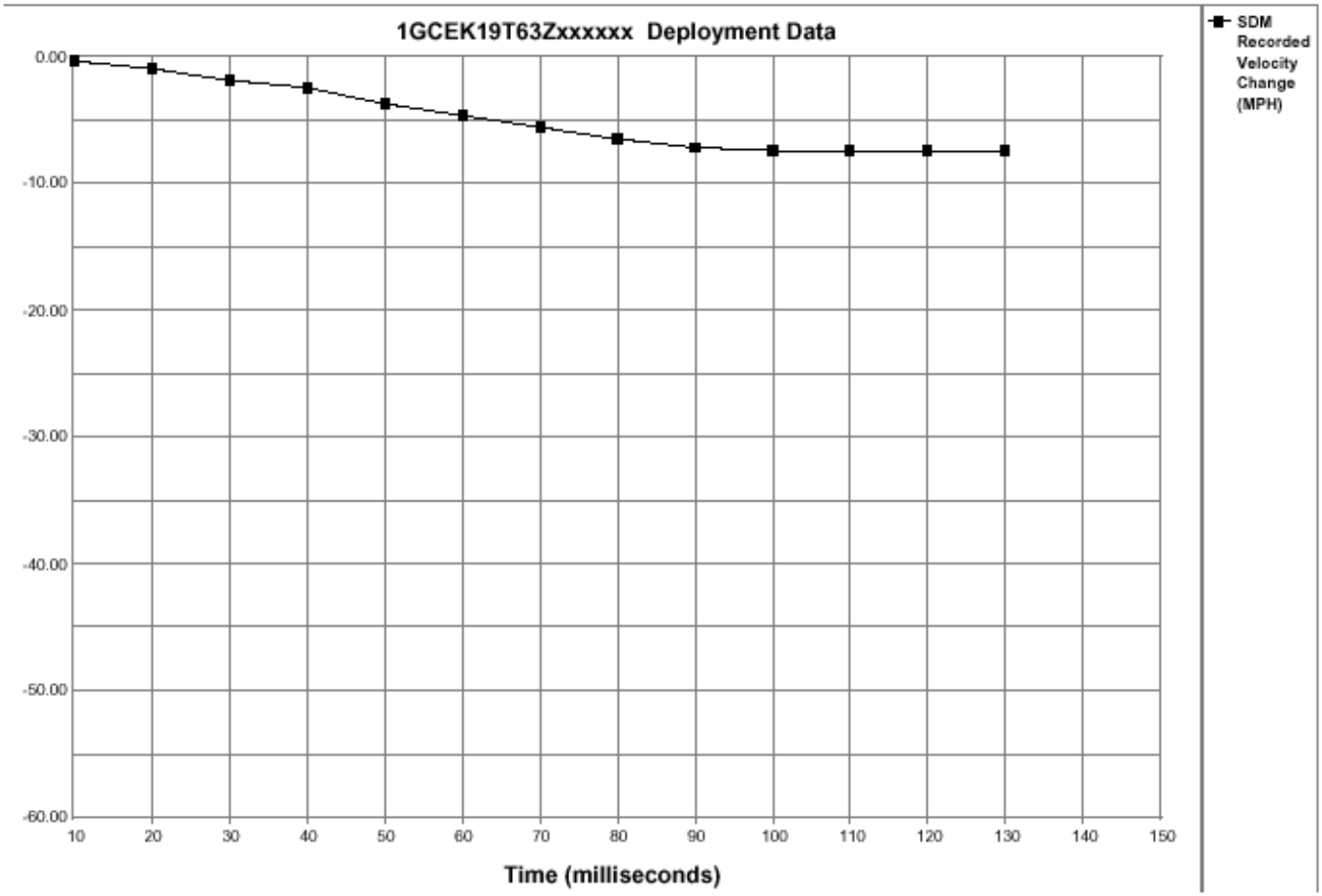
CDR CRASH DATA RETRIEVAL SYSTEM

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Deployment	522
Ignition Cycles At Investigation	525
Maximum SDM Recorded Velocity Change (MPH)	-7.57
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	180
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	37.5
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	34	1344	0	OFF
-4	35	1344	0	OFF
-3	35	1408	0	OFF
-2	36	1472	5	OFF
-1	34	1344	0	ON



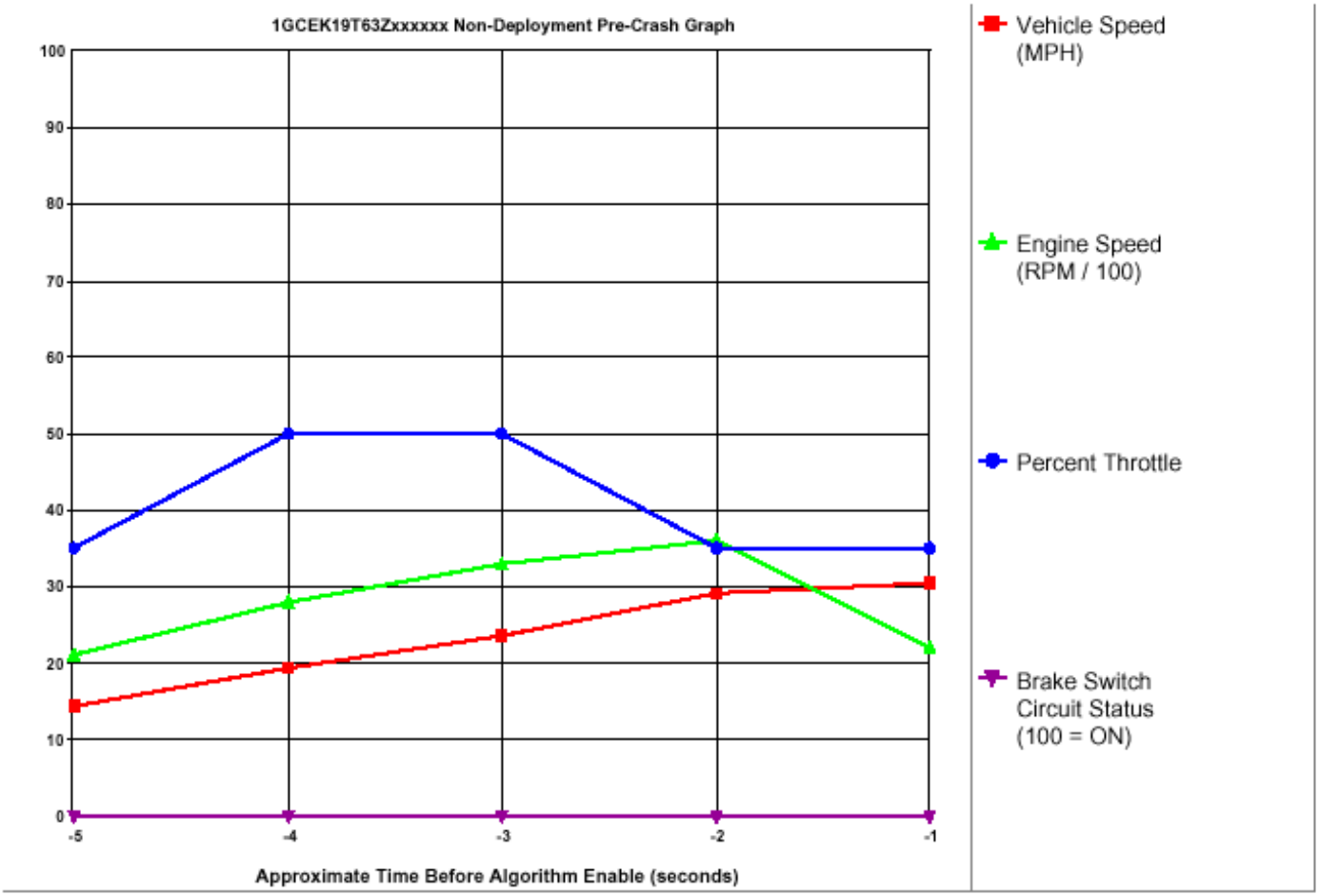
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.31	-0.93	-1.86	-2.48	-3.72	-4.65	-5.58	-6.51	-7.13	-7.44	-7.44	-7.44	-7.44	N/A	N/A

Vetronix

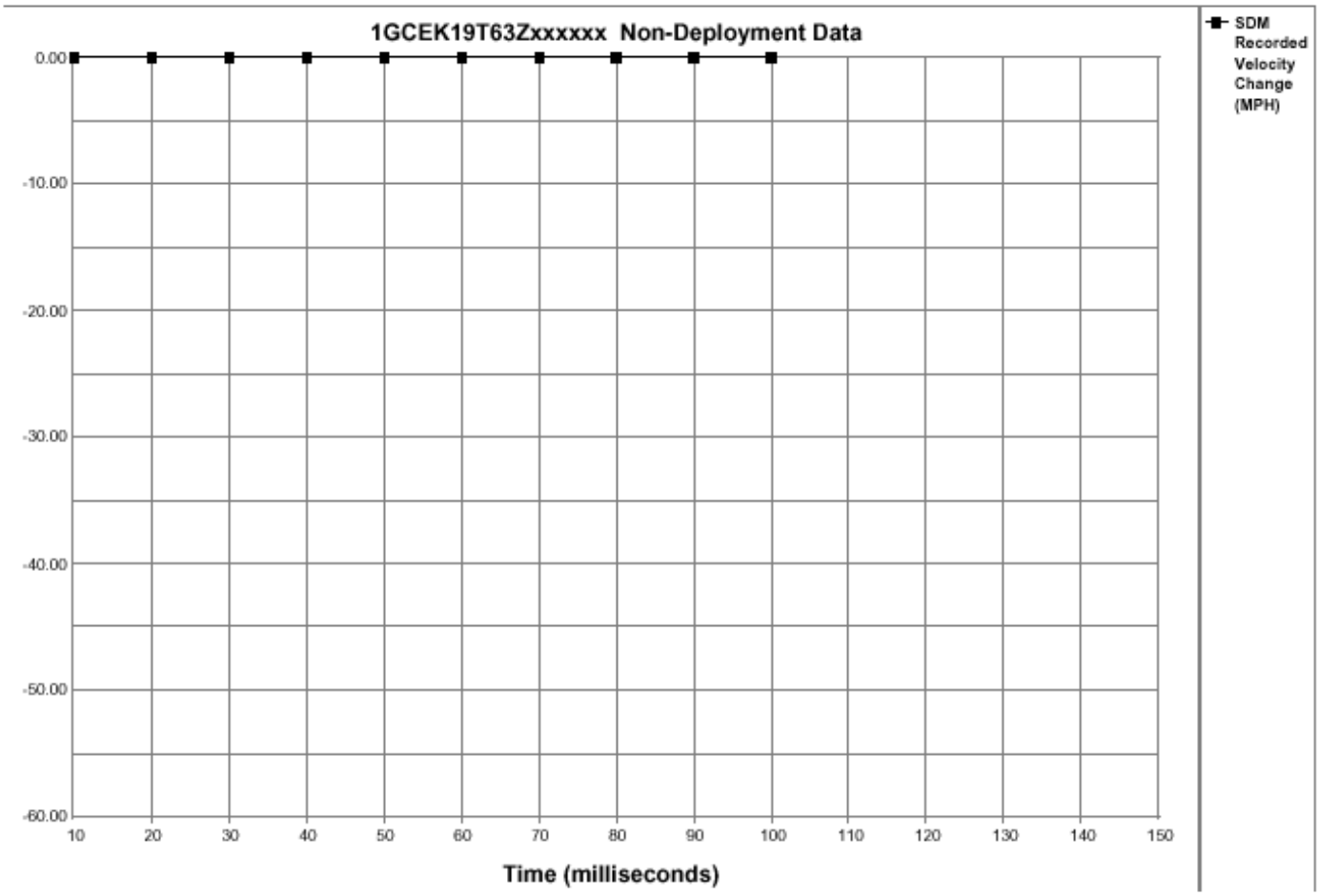
CDR CRASH DATA RETRIEVAL SYSTEM

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Non-Deployment	292
Ignition Cycles At Investigation	525
Maximum SDM Recorded Velocity Change (MPH)	-0.08
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



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	14	2112	35	OFF
-4	19	2752	50	OFF
-3	24	3328	50	OFF
-2	29	3584	35	OFF
-1	30	2240	35	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