

Certified Advanced 208 Compliant Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS03005
2003 Chevrolet Tahoe 4X4 SUV
Colorado
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 crash-worthiness performance of the involved vehicle(s) or their safety systems.

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16. Abstract <p>This on-scene, in-depth investigation focused on the Certified Advanced 208 Compliant vehicle. This two vehicle crash took place in January, 2003 at 1716 hours. The weather was clear and the level bituminous/asphalt surface was dry. It was dark at the time, but the roadway was lighted by overhead luminaires. The crash occurred in lane four of a five lane, westbound, divided interstate highway. This highway consists of westbound travel lanes and eastbound travel lanes which are separated by a positive center concrete barrier. There were no traffic controls present and the speed limit is 105 km/h (65 mph).</p> <p>The case vehicle was a fleet rental 2003 Chevrolet Tahoe 4x4 full size sport utility vehicle and was being driven by a fully restrained 26 year-old female. The third row left side position was occupied by a 6 year-old male who also was wearing the available three-point manual lap and shoulder restraint. The SDM non-deployment data indicated that the driver's belt switch status was BUCKLED and the vehicle travel speed was 56 km/h (35 mph) five seconds before AE. The brake switch was OFF from 5 through 2 seconds before AE. The case vehicle was traveling westbound in lane four at a police reported travel speed of 48 km/h (30 mph).</p> <p>The other vehicle is a 2003 Pontiac Grand AM SE four-door sedan was being driven by a 37 year-old male. The front, right seat was occupied by a 44 year-old female while a restrained 43 year-old male occupied an unknown seated position of the rear seat.</p> <p>Both involved vehicles were traveling westbound in lane four and the other vehicle (2003 Pontiac Grand AM) was traveling ahead of the case vehicle and had just slowed due to heavy traffic at the time. The driver of the case vehicle detected the slowing traffic and applied the brake 1 second before the impending impact as per downloaded SDM results. The front of the case vehicle impacted (12FDEW1) the rear of the other vehicle in a front to rear axial collision. The frontal air bags in the case vehicle did not deploy due to the low impact speed. The total velocity change calculated by the missing vehicle algorithm of the WinSmash collision model was 7.0 km/h (4.3 mph). The longitudinal delta V was 7.0 km/h (-4.3 mph) which was well below the threshold necessary for air bag deployment. This was a borderline reconstruction as crush values were determined to be 1 cm (C1-C6) based upon supplied photos from insurance company. There were no reported injuries for the occupants of the case vehicle and no reported injuries for the driver or occupants of the other vehicle.</p>					
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Dynamic Science, Inc.
Crash Investigation
Case Number: DS03005

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BACKGROUND:

Description: This Advanced 208 Compliant case was initially identified by a NHTSA review of GES police reports. This vehicle is certified by the manufacturer to be compliant to Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The police report was forwarded to DSI on February 5, 2003 with instructions to locate the case vehicle for an on-scene investigation. The case vehicle is a fleet rental vehicle and at the time the case was assigned to DSI the vehicle had been repaired and was out on a long term rental. The rental company cooperated and agreed to notify DSI when the vehicle was returned to the rental facility. On March 17, 2003 the rental company notified DSI that the case vehicle was being held for inspection. The case vehicle was inspected and the data from the Sensing Diagnostic Module (SDM) downloaded. All field activities were completed on March 21, 2003. Photographs of the damaged vehicle were obtained.

Investigation Type:	Certified Advanced 208 Compliant
Crash Location:	Colorado
Crash Date:	January, 2003
Notification Date:	February 5, 2003
Field Work Completed:	March 21, 2003

SUMMARY

Crash Site

This on-scene, in-depth investigation focused on the non-deployment of advanced air bags in a 208 Compliant vehicle. This two vehicle crash took place in January, 2003 at 1716 hours. The weather was clear and the level bituminous/asphalt surface was dry. It was dark at the time, but the roadway was lighted by overhead luminaires. The crash occurred in lane four of a five lane, westbound, divided interstate highway. This highway consists of westbound travel lanes and eastbound travel lanes which are separated by a positive center concrete barrier. There were no traffic controls present and the speed limit is 105 km/h (65 mph).



Figure 1. Westbound view showing impact location

Pre-Crash

The case vehicle was a fleet rental 2003 Chevrolet Tahoe 4x4 full size sport utility vehicle and was being driven by a fully restrained 26 year-old female. The third row left side position was occupied by a 6 year-old male who also was wearing the available three-point manual lap and shoulder restraint. The SDM non-deployment data indicated that the driver's belt switch status was BUCKLED and the vehicle travel speed was 56 km/h (35 mph) five seconds before AE. The brake switch was OFF from 5 through 2 seconds before AE. The case vehicle was traveling westbound in lane four at a police reported travel speed of 48 km/h (30 mph).



Figure 2. Full frontal view of case vehicle showing minor front bumper deformation

The other vehicle is a 2003 Pontiac Grand AM SE four-door sedan was being driven by a 37 year-old male. The front right seat was occupied by a 44 year-old female while a restrained 43 year-old male occupied an unknown seated position of the rear seat.

Both involved vehicles were traveling westbound in lane four and the other vehicle (2003 Pontiac Grand AM) was traveling ahead of the case vehicle and had just slowed due to heavy traffic at the time. The driver of the case vehicle detected the slowing traffic and applied the brake 1 second before the impending impact as per downloaded SDM results.

Crash

The front of the case vehicle impacted (12FDEW1) the rear of the other vehicle in a front to rear axle collision. The frontal air bags in the case vehicle did not deploy due to the low impact speed crash. The total velocity change calculated by the missing vehicle algorithm of the WinSmash collision model was 7.0 km/h (4.3 mph). The longitudinal delta V was 7.0 km/h (-4.3 mph) which was well below the threshold necessary for air bag deployment. This was a borderline reconstruction as crush values were determined to be 1 cm (C1-C6) based upon supplied photos from insurance company.

Post-Crash

There were no reported injuries for the occupants of the case vehicle and no reported injuries for the driver or occupants of the other vehicle. After the investigating police collected all of the pertinent information, the involved drivers drove their respective vehicles from the crash location.

VEHICLE DATA - 2003 Chevrolet Tahoe 4X4 SUV

VIN: 1GNEK13Z73JXXXXXX
 Odometer: 21,762 kilometers (13,522 miles)
 Engine: 5.3 L/ V8
 Reported Defects: None Reported

The 2003 Chevrolet Tahoe 4X4 SUV was equipped with Firestone P265/70R16 Wilderness LE brand tires. The vehicle manufacturer's recommended cold tire pressure for the front and rear tires is 241 kPa (35 psi). The specific tire data is as follows:

Tire	Tread	Pressure	Tire Manufacture Maximum Recommended Pressure
LF	8 mm (10/32 in)	228 kPa (33 psi)	276 kPa (40 psi)
LR	7 mm (09/32 in)	234 kPa (34 psi)	276 kPa (40 psi)
RR	8 mm (10/32 in)	241 kPa (35 psi)	276 kPa (40 psi)
RF	7 mm (09/32 in)	234 kPa (34 psi)	276 kPa (40 psi)

The front seating positions in the 2003 Chevrolet Tahoe 4X4 SUV consist of fabric covered forward facing bucket seats. Both front bucket seats are equipped with adjustable head restraints. The front, right bucket seat was unoccupied.

VEHICLE DAMAGE

Exterior Damage - 2003 Chevrolet Tahoe 4X4 SUV

Damage Description:	<u>Minor/Primary Frontal Impact (Highest Delta V):</u> Slight longitudinal displacement of front bumper. Depression noted approximately 13 cm (5.1 in.) left of vehicle centerline. Minor depression noted to hood edge.	
CDC:	12FDEW1	
Delta V:	Total	7.0 km/h ¹ (4.3 mph)
	Longitudinal	-7.0 km/h (-4.3 mph)
	Latitudinal	0.0 km/h (0.0 mph)
	Energy	2446 Joules (1804 ft/lbs)

C measurement: No crush profile obtained/ Insurance photos of original damage obtained. Damage and CDC estimated from photos only.

Interior Damage - 2003 Chevrolet Tahoe 4X4 SUV

The interior greenhouse area of the case vehicle was void of any intruding components and the case vehicle's integrity was not compromised. All glazing remained undamaged and the doors and rear door did not open, remained operational with no damage noted. The case vehicle had been repaired upon vehicle inspection. The interior was void of occupant contacts which is consistent with no reported injuries. Both frontal air bag units were non-deployed as a result of the minor impact force.

The second row consists of a 60/40 folding bench seat and is comprised of three seated positions with adjustable head restraints at the outboard positions and an integrated head restraint at the middle position. There was no noted damage to the second row of seats. The third row consists of a split 50/50 bench with folding backs and has adjustable head restraints at the outboard positions. It should be noted that at the time of inspection, the third row bench seats were found with the seatbacks folded down facing rearward and not locked on the floor. There was no damage to the third row of seats.

MANUAL RESTRAINT SYSTEMS - 2003 Chevrolet Tahoe 4X4 SUV

The driver's manual restraint system consisted of a seat integrated continuous loop three-point manual lap and shoulder belt equipped with a sliding latch plate. The emergency locking retractor (ELR) was integrated into the front left seatback support. The driver's manual three-

¹ Calculated using the missing vehicle algorithm with a CDC only for the case vehicle. Crush profile was estimated at 1 cm (0.4 in) for C1 through C6. NCAP test used to calculate size and stiffness coefficients for case vehicle. Results are consistent with maximum SDM recorded velocity change (-4.89 mph).

front lap and shoulder belt exhibited evidence of historical usage as scratching and metal striations were noted to the latch plate component. Given the low impact speed, there was no evidence of loading to the belt webbing or other restraint components. The non-deployment event recorded by SDM indicated that the driver's belt switch circuit was "BUCKLED".

The front, right manual restraint system also consisted of a seat integrated continuous loop-three-point manual lap and shoulder belt equipped with a sliding latch plate. The emergency locking retractor (ELR) was integrated into the front, right seatback support. The restraint system exhibited evidence of historical usage as striations were documented to the latch plate.

The second row seat positions are equipped with lap and shoulder belts and all latch plates indicated historical usage as evidenced by scratches and striations to the latch plate metal surface. The right and middle seats were equipped with Lower Anchors and Tethers for Children (LATCH).

The third row seat accommodates three passengers. The two outboard seat positions are equipped with lap and shoulder restraints and the middle position is equipped with a manual two-point lap belt. All three latch plates demonstrated evidence (scratches/striations) of historical usage.

FRONTAL AIR BAG SYSTEM - 2003 Chevrolet Tahoe 4X4 SUV

Advanced Occupant Protection System Discussion

This vehicle was equipped with an advanced occupant protection system certified by the manufacturer to be compliant with the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. 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.

The downloaded data indicates a non-deployment event was recorded. The case vehicle had a maximum recorded velocity change of -7.87 km/h (-4.89 mph) at the 122.5 ms mark.

The Vetronix system status at non-deployment indicates that:

1. SIR warning lamp status was OFF.
2. The driver's belt switch status was BUCKLED.
3. Ignition cycles at non-deployment 990.
4. Ignition cycles at investigation 1185. The difference of 195 ignition cycles is due to the vehicle being rented out on a long term rental after the vehicle was repaired.
5. Maximum SDM recorded velocity change -7.87 km/h (-4.89 mph).
6. Algorithm enable (AE) to maximum SDM recorded velocity change was 122.5 milliseconds.
7. Event recording complete.
8. Multiple events associated with this record NO.
9. One or more associated events not recorded NO.



Figure 3. Not deployed driver's air bag



Figure 4. Not deployed front right passenger's air bag

10. The vehicle speed was 56 km/h (35 mph) five seconds before AE, accelerated to 58 km/h (36 mph) at 4 seconds before AE, 61 km/h (38 mph) at 3 seconds before AE, and 63 km/h (39 mph) at 2 and 1 seconds before AE.
11. The brake switch status was OFF from 5 through 2 seconds before AE, and was ON for 1 second before AE.

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 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, another means of determining what may be on the seat.

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.



Figure 5. Front right Passenger Sensing System



Figure 6. Passenger Sensing System monitored on rear view mirror

VEHICLE DATA - 2003 Pontiac Grand Am

Description:	2003 Pontiac Grand Am four-Door Sedan	
VIN:	1G2NE52F23CXXXXXX	
Odometer:	Unknown	
Engine:	2.2 Liter/ 4 Cyl.	
Reported Defects:	None Reported	
Cargo:	Unknown	
Damage Description:	<u>Unknown</u> : Reportedly light rear bumper damage, vehicle driven from crash location.	
CDC:	Unknown	
Delta V (Missing Vehicle):	Total	12.0 km/h (7.5 mph)
	Longitudinal	12.0 km/h (7.5 mph)
	Latitudinal	0.0 km/h (0.0 mph)
	Energy	10,448 Joules (7,706 ft/lbs)

OCCUPANT DEMOGRAPHICS - 2003 Chevrolet Tahoe 4X4 SUV

	Occupant 1	Occupant 2
Age/Sex:	26/Female	6/Male
Seated Position:	Front, left	Third row, left side
Seat Type:	Bucket, fabric covered seat	50/50 bench with folding backs
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	N/A
Pre-existing Medical Condition:	Unknown	N/A
Alcohol/Drug Involvement:	None	N/A
Driving Experience:	Unknown	N/A
Body Posture:	Upright, specifics are unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Right foot depressing brake pedal, left foot on floor (based on SDM non-deployment output data)	Unknown
Restraint Usage:	Three-point, manual lap and shoulder restraint used in a presumed normal and correct fashion with the shoulder belt webbing extending across her front and the lap belt webbing placed across her hip region.	Three-point, manual lap and shoulder restraint used (based upon inspection and police report data). Unknown if restraint used in a correct fashion.
Air bag:	Steering wheel mounted air bag available. Driver's air bag did not deploy with the longitudinal delta V calculated at -7.0 km/h (-4.3 mph).	None available

OCCUPANT DEMOGRAPHICS - 2003 Pontiac Grand Am

Age/Sex:	37/Male	44/Female
Seated Position:	Front, left	Front, right
Seat Type:	Bucket	Bucket
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	Unknown	Unknown
Alcohol/Drug Involvement:	None	N/A
Driving Experience:	Unknown	N/A
Body Posture:	Upright, specifics are unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Right foot depressing brake pedal as per narrative description on police accident report	Unknown
Restraint Usage:	Police report indicated lap and shoulder restraint used	Police report indicated lap and shoulder restraint used

OCCUPANT DEMOGRAPHICS - other vehicle (Cont.)

Age/Sex:	43/Male
Seated Position:	Rear Seat, unknown position
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	Unknown
Alcohol/Drug Involvement:	N/A
Driving Experience:	N/A
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Police report indicated lap and shoulder restraint used

OCCUPANT INJURIES -2003 Chevrolet Tahoe 4X4 SUV

	Injury	OIC Code	Injury Mechanism	Confidence Level
Driver:	Uninjured	N/A	N/A	N/A
Third row, left side seated occupant:	Uninjured	N/A	N/A	N/A

OCCUPANT INJURIES - other vehicle

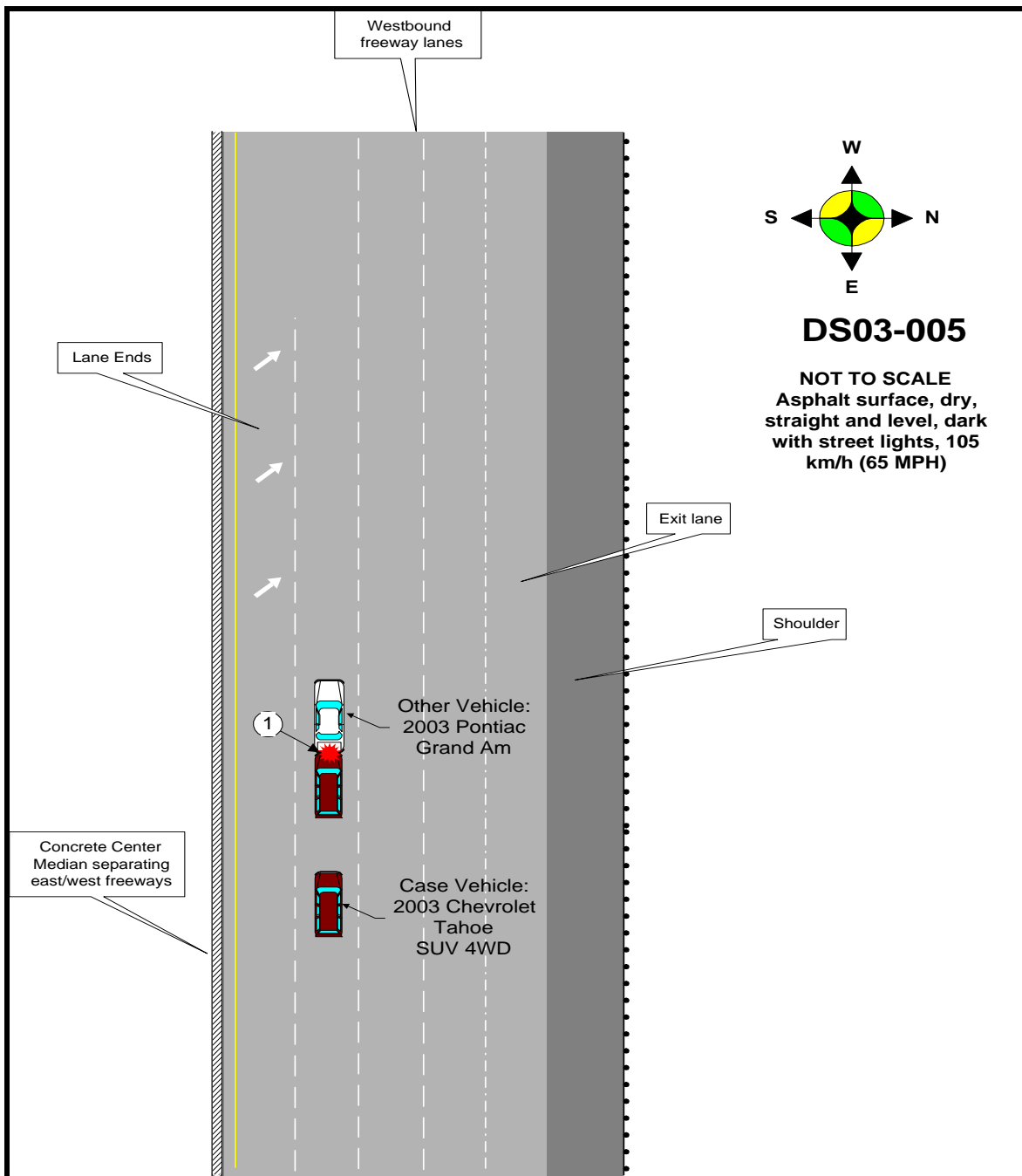
	Injury	OIC Code	Injury Mechanism	Confidence Level
Driver:	Reported to be Uninjured	N/A	N/A	N/A
Front, right passenger	Reported to be Uninjured	N/A	N/A	N/A
Rear passenger	Reported to be Uninjured	N/A	N/A	N/A

OCCUPANT KINEMATICS - 2003 Chevrolet Tahoe 4X4 SUV

The 26 year old female driver was wearing the available three-point manual lap and shoulder restraint in a normal and presumed correct fashion. According to downloaded SDM non-deployment data, the brake switch was activated ON 1 second prior to AE. Her right foot was depressing the brake pedal and her left foot was likely on the floor as the front of the case vehicle impacted the rear of the other vehicle. She responded to the 12 o'clock impact force by moving forward. The applied lap and shoulder restraint restricted her upper and lower torso from extended forward movement. She did not contact any interior components and rebounded into her respective seatback support. The driver of the case vehicle was uninjured and did not require treatment at the scene.

The third seat, left side position was occupied by a 6 year old male who was likely wearing the available three-point manual lap and shoulder restraint . He responded to the 12 o'clock impact force by moving forward. The applied lap and shoulder restraint restricted extended forward movement of the child's upper and lower torso. There was no evidence to suggest that he contacted an interior component and he was reportedly uninjured.

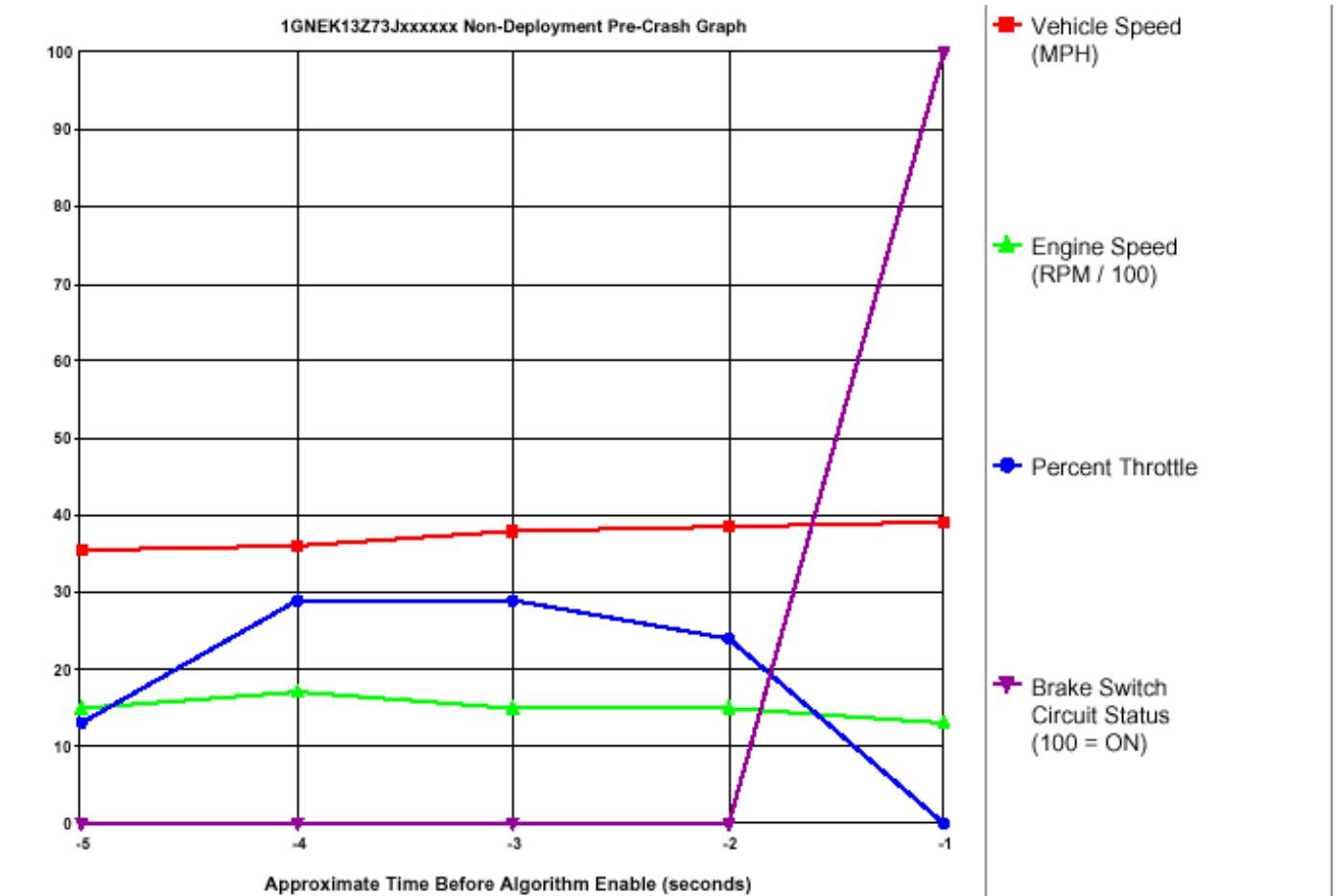
ATTACHMENT 1 - SCENE DIAGRAM



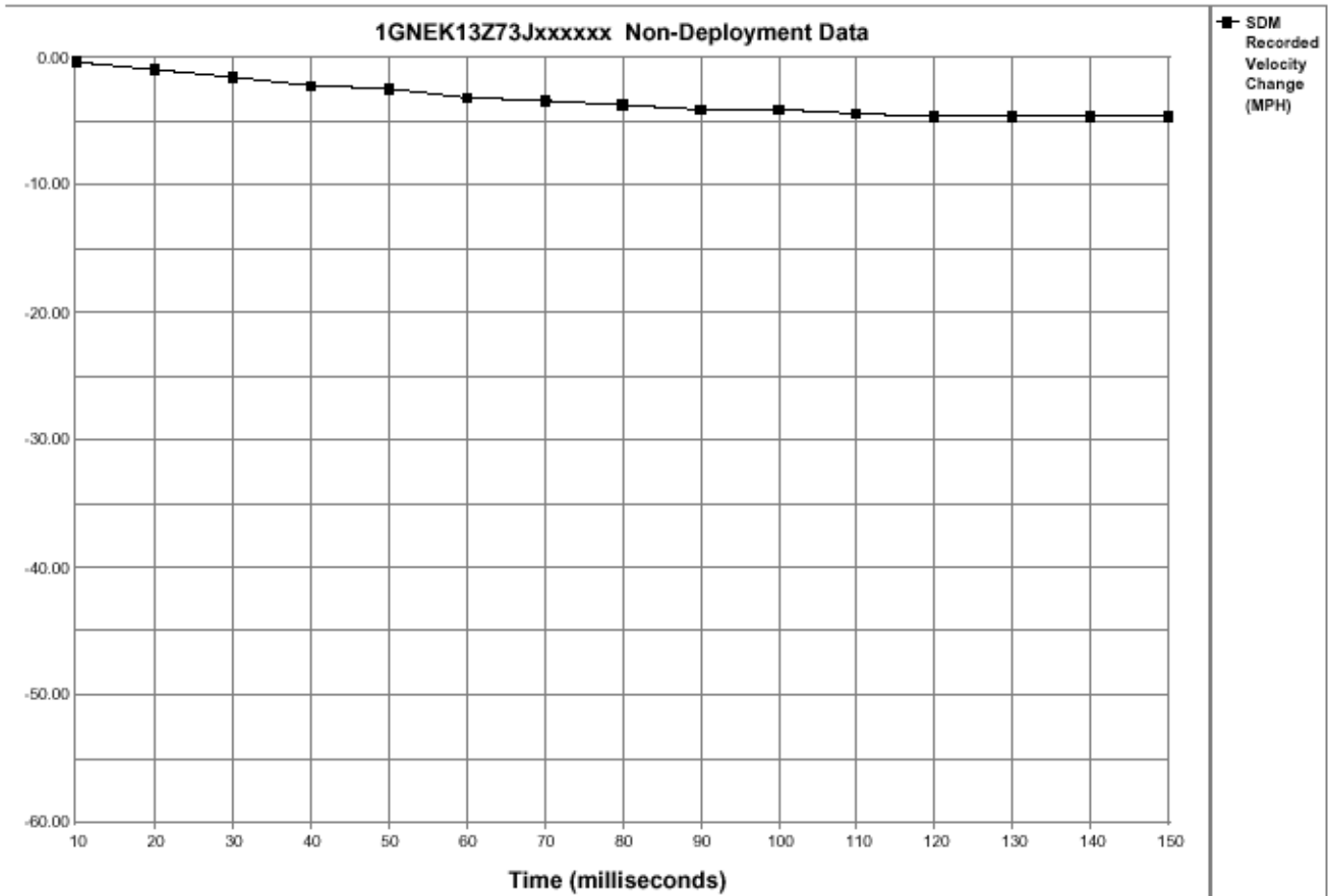
ATTACHMENT 2 - Vetronix Report

**System Status At Non-Deployment**

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	990
Ignition Cycles At Investigation	1185
Maximum SDM Recorded Velocity Change (MPH)	-4.89
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	122.5
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	35	1536	13	OFF
-4	36	1664	29	OFF
-3	38	1536	29	OFF
-2	39	1536	24	OFF
-1	39	1280	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	-1.55	-2.17	-2.48	-3.10	-3.41	-3.72	-4.03	-4.03	-4.34	-4.65	-4.65	-4.65	-4.65