

Rollover/Electronic Stability Control Investigation/Vehicle to Vehicle
Dynamic Science, Inc./Case Number: DS05028
2005 Cadillac Escalade
Arizona
June 2005

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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>This on-site investigation focused on the Electronic Stability Control system in a 2005 Cadillac Escalade. This two-vehicle crash with a rollover occurred in June 2005 at 0819 hours in the state of Arizona. The case vehicle is a 2005 Cadillac Escalade that was equipped with electronic stability control. According to Cadillac, the Escalade is equipped with "Stabilitrac", which helps prevent skids; traction control, which prevents wheel spin; and Road Sensing Suspension, which continuously adjusts the shock absorbers for road conditions." The Cadillac Escalade was struck on the left side by a 2003 Honda Accord in an intersection type crash. The Cadillac was redirected to the right where it struck a pole with its right side and then rolled over one quarter turn onto its right side. The driver of the Cadillac sustained non life threatening injuries. He was transported by ground ambulance to a local hospital. The driver of the Honda did not report any injuries. Both vehicles were towed from the scene due to damage. The Escalade was later declared a total loss by the insurance company.</p>					
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BACKGROUND:

Description

This on-site investigation focused on the Electronic Stability Control system in a 2005 Cadillac Escalade. This two-vehicle crash with a rollover occurred in June 2005 at 0819 hours in the state of Arizona. The case vehicle is a 2005 Cadillac Escalade that was equipped with electronic stability control. According to Cadillac, the Escalade is equipped with “Stabilitrac”, which helps prevent skids; traction control, which prevents wheel spin; and Road Sensing Suspension, which continuously adjusts the shock absorbers for road conditions.” The Cadillac Escalade was struck on the left side by a 2003 Honda Accord in an intersection type crash. The Cadillac was redirected to the right where it struck a pole with its right side and then rolled over one quarter turn onto its right side. The driver of the Cadillac sustained non life threatening injuries. He was transported by ground ambulance to a local hospital. The driver of the Honda did not report any injuries. Both vehicles were towed from the scene due to damage. The Escalade was later declared a total loss by the insurance company.

This Rollover/Electronic Stability Control Investigation case was identified by DSI from insurance sources. DSI was assigned the case on November 29, 2005. DSI obtained permission to inspect the vehicle and download the electronic data recorder on December 2, 2005. The case vehicle was inspected on December 5, 2005. The Electronic Data Recorder (EDR) data was downloaded during the vehicle inspection. The EDR summary report is included as Attachment 2 at the end of this report. The system recorded a Non-Deployment Event as a result of the impact with the Honda.



Figure 1. Cadillac Escalade, left side damage



Figure 2. Case vehicle approach to area of impact



Figure 3. Other vehicle approach

SUMMARY

Crash Site

The crash occurred within the confines of a four-leg intersection in June 2005. At the time of the crash, the asphalt roadway surface was dry, there were no adverse weather conditions and there were no visual obstructions present. The northbound roadway was configured with two northbound through lanes, a left turn lane, a raised median and two southbound through lanes. The eastern roadway was comprised of an eastbound travel lane and a westbound travel lane. The western roadway was a private driveway that allows travel in both directions. The southbound roadway was configured with two southbound through lanes, a left turn lane, a raised median and two northbound through lanes. The roadways were controlled by overhead tri-color traffic signals. The posted speed limit was 48 km/h (30 mph).

Pre-Crash

The 2005 Cadillac Escalade was traveling northbound in the far right lane traveling through the four leg intersection. The Cadillac was being driven by a 62-year-old male (180 cm/71 in, 136 kg/300 lbs). He was not wearing the manual 3-point lap and shoulder belt. The seat was adjusted to the rearmost track position and the seat back was slightly reclined. He was wearing eyeglasses at the time of the crash. The other vehicle was a 2003 Honda Accord that was being driven by a 81-year-old female. The Accord was stopped in the left turn lane facing south. As the light turned green for north and southbound traffic, the Accord began a left hand turn to go east. When the driver of the Escalade detected the approaching Honda, the driver began applying the brakes. The EDR reported speed for the Escalade one second prior to impact was 72 km/h (45 mph). Brake application was based on the EDR pre-crash data which showed the brake switch circuit status as "ON", one second prior to impact.

Crash

As the Accord continued its turn, it struck the left side of the Cadillac (11LPEW2) with its front end. This contact extended into the Escalade's left rear wheel well and the left rear tire was torn away.

The impact was relatively minor. The EDR-reported maximum velocity change was -9.46 km/h (-5.88 mph), 220 milliseconds into the crash.



Figure 4. Area of impact. Also shows area of impact with traffic signal pole.

The missing vehicle routine of the WinSmash program computed a total delta V of 6.0 km/h (3.7 mph). The longitudinal and lateral components were -5.6 km/h (-3.5 mph) and 2.1 km/h (1.3 mph), respectively.

The EDR reported speed one second prior to impact was 72 km/h (45 mph). Brake application was based on the EDR pre-crash data, which showed the brake circuit status as “ON”, one second prior to impact. The snagging action at the left rear wheel area caused the Cadillac to begin a counterclockwise rotation. The vehicle departed the roadway at the northeast corner of the intersection and struck the metal traffic signal with its right side (03RPAN3). According to witnesses, the pole was deformed and almost fell to the ground. The Cadillac was directed by the pole impact and tripped onto its right side (0ORDAO2) where it came to rest facing west.

Post-Crash

The driver was able to climb out of the side window unaided. Emergency personnel arrived on scene shortly after the crash. The driver sustained a forehead laceration that required three stitches, a small laceration on the right side of the forehead, and a contusion to the left forearm. He was transported by ground ambulance to a local Level 1 trauma center where he was treated and released.

VEHICLE DATA - 2005 Cadillac Escalade

The 2005 Cadillac Escalade sport utility vehicle was identified by the Vehicle Identification Number (VIN): 1GYEK63N85Rxxxxxx. The vehicle’s digital odometer could not be read due to a lack of power. The Cadillac sport utility vehicle was equipped with a 6.0 liter, eight-cylinder engine, a four-speed automatic transmission, front and rear disc brakes, power steering, and a tilt steering wheel.

The Cadillac Escalade was equipped with Goodyear Wrangler HP P265/70R17 tires. The left rear tire was knocked off during the crash. The recommended cold tire pressure was 207 kPa (30 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Flat	6 mm (8/32 in)	No	Hole in carcass
LR	Unknown- Torn Off	Unknown	No	Unknown
RR	Flat	7 mm (9/32 in)	No	Rim cracked
RF	221 kPa (32 psi)	6 mm (8/32 in)	No	No

The seating in the Cadillac Escalade was configured with leather covered front bucket seats with adjustable head restraints and a rear split bench seat. The driver’s seat was adjusted to the rearmost track position (8.0 cm/3.1 in rear of track end). The front seat backs were at a 63 degree angle. The front seat bottoms were at a 14 degree angle. The rear seat angles for the seat backs and seat bottoms were 68 and 11 degrees, respectively.

Vehicle Damage - 2005 Cadillac Escalade

Exterior Damage

The 2005 Cadillac Escalade sustained moderate left side damage as a result of the impact with the Honda. The direct damage began 51.0 cm (20.0 in) rear of the left front axle and extended 196.0 cm (77.1 in) rearward along the left side plane. The damage was at the sill level and extended into the left rear wheel well. The left rear tire was torn from the vehicle. The combined direct and induced damage location began and ended at the same locations as the direct contact. Six crush measurements were documented at the sill level as follows: C1 = 0.0 cm (0.0 in), C2 = 7.0 cm (2.7 in), C3 = 10.0 cm (3.9 in), C4 = 14.0 cm (5.5 in), C5 = 16.0 cm (6.3 in), C6 = 0.0 cm (0.0 in). The Collision Deformation Classification (CDC) for the impact with the Honda was 11LPEW2.

There was moderate damage to the right side of the Escalade from the impact with the pole. The direct damage began 27.0 cm (10.6 in) forward of the rear axle and extended 22.0 cm (8.6 in) forward along the right side plane. The combined direct and induced damage began 114.0 cm (44.9 in) forward of the rear axle and extended rearward along the right side plane. The maximum lateral crush was located 14.0 cm (5.5 in) rearward of C4 and measured 30.0 cm (11.8 in). Six crush measurements were documented at the belt line as follows: C1 = 0.0 cm (0.0 in), C2 = 3.0 cm (1.2 in), C3 = 17.0 cm (6.7 in), C4 = 24.0 cm (9.4 in), C5 = 9.0 cm (3.5 in), C6 = 0.0 cm (0.0 in). The CDC for the impact with the pole was 03RPAN3. There was 14.0 cm (5.5 in) lateral and 8.0 cm (3.1 in) vertical crush at the C pillar.

There was 455.0 cm (179.1 in) of direct contact damage along the entire right side from contact with the ground during the rollover. The damage began 68.0 cm (26.7 in) forward of the front axle and extended rearward to the end of the vehicle. The CDC for the rollover was 00RDAO2.

The right rear tire was flat and the rim was cracked. There was damage to the right front tire rim, but the tire remained inflated. The right side doors, the second row left door, and the hatch were all jammed shut. The glazing at the front right door, the right rear area, and the hatch were disintegrated. The glazing damage at the right rear area most likely occurred during the pole impact.



Figure 5. Left sill damage from impact with Honda

CDC: Impact 1: 11LPEW2
 Impact 2: 03RPAN3
 Impact 3: 00RDAO2

Delta V (Impact 1):	Total	6.0 km/h (3.7 mph)
	Longitudinal	-5.6 km/h (-5.3 mph)
	Latitudinal	2.1 km/h (1.3 mph)
	Energy	17,908 joules (13,208 ft lbs)

Delta V (Impact 2) ¹ :	Total	12.0 km/h (7.5 mph)
	Longitudinal	0 km/h (0 mph)
	Latitudinal	-12.0 km/h (-7.5 mph)
	Energy	23,005 joules (16,968 ft lbs)



Figure 6. Right side pole and rollover damage



Figure 7. Lateral/vertical crush at the C pillar

¹Computed using Barrier option. Barrier Equivalent Speed only coded into the EDS.

Interior Damage

The 2005 Cadillac Escalade sustained moderate interior damage as a result of passenger compartment intrusion and occupant contacts. The right C pillar, right roof header, right front door, and left sill sustained lateral intrusion. The second row right seat had been compressed laterally to the left and towards the rear of the vehicle by the C pillar intrusion.

Position	Intruded Component	Magnitude of Intrusion	Direction
RR	C pillar (metal)	42.0 cm (16.5 in)	Lateral
RR	C pillar (plastic)	57.0 cm (22.4 in)	Lateral
RR	Roof header	26.0 cm (10.2 in)	Lateral
RF	Door	5.0 cm (2.0 in)	Lateral
LF	Sill	10.0 cm (3.9 in)	Lateral
Cargo	Side panel, second row seat back, right side rail	Unknown	Lateral

The windshield cracked on the right side from occupant contact. There were blood contacts and smears found on the second row right window, the right door, along the right front head restraint, the roof, the right B pillar, along the roof rail, and on the front right passenger seat belt webbing. The left side of the center console had been contacted by the driver's right hip and moved laterally to the right. The instrument panel fascia on the left side had been dislodged.



Figure 8. Overview of right side intrusion

Manual restraints - 2005 Cadillac Escalade

The 2005 Cadillac Escalade was configured with manual 3-point lap and shoulder belts for each seating position. Both integral front safety belts were equipped with pretensioners. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The driver's belt was not used during the crash. The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).

Supplemental Restraint System - 2005 Cadillac Escalade

The 2005 Cadillac Escalade was equipped with dual-stage frontal air bags and safety belt retractor pretensioners for the driver and front right passenger positions. The Escalade was also equipped with seat back mounted side air bags for the two front seat positions. There were no air bag deployments and no pretensioner actuations. This vehicle was equipped with an advanced occupant protection system. The system consists of the Sensing and Diagnostic Module (SDM), dual-level (dual stage) driver and front right passenger air bags, a front right passenger sensing system, seat mounted side air bags at both front seat positions, and a driver's and front right passenger'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 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. One event was recorded by the SDM, a Non-Deployment event at 3173 ignition cycles.

The Vetronix system status at Non-Deployment report indicates that:

1. SIR warning lamp status was OFF.
2. The driver's belt switch status was UNBUCKLED.
3. Ignition cycles at non-deployment 3173.
4. Ignition cycles at investigation 3183.
5. Maximum SDM recorded velocity change -9.4 km/h (-5.88 mph).
6. Algorithm enable (AE) to maximum SDM recorded velocity change was 220 milliseconds.
7. Crash record locked NO.
8. Event recording complete YES.
9. Multiple events associated with this record NO.
10. One or more associated events not recorded NO.
11. The vehicle speed was 72 km/h (45 mph) 5 seconds before AE and hovered between 74 km/h (46 mph) and 72 km/h (45 mph) until 1 second before AE.
12. The brake switch status was OFF from 5 through 2 seconds before AE, and went to ON 1 second before AE.

VEHICLE DATA - 2003 Honda Accord

Description:	2003 Honda Accord	
VIN:	1HGCM56313Axxxxxx	
Odometer:	Unknown	
Engine:	2.4L/4 cylinder	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Unknown	
CDC:	Unknown	
Delta V:	Total	11.0 km/h (6.8 mph)
	Longitudinal	-4.6 km/h (-2.9 mph)
	Latitudinal	-10.0 km/h (-6.2 mph)
	Energy	10,610 joules (7,826 ft lbs)

OCCUPANT DEMOGRAPHICS - 2005 Cadillac Escalade

	Driver
Age/Sex:	62/Male
Seated Position:	Front left
Seat Type:	Bucket seat. Seat adjusted to the rearmost track position. Seat back slightly reclined.
Height:	180 cm (71 in)
Weight:	136 kg (300 lbs)
Occupation:	Realtor
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Normal, upright
Hand Position:	Both on steering wheel, unknown o'clock positions.
Foot Position:	Left foot on floor. Right foot on brake.
Restraint Usage:	Lap and shoulder belt available, not used
Air bag:	Steering wheel mounted frontal air bag available, did not deploy.

OCCUPANT DEMOGRAPHICS - 2003 Honda Accord

Age/Sex:	81/Female
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Presumed to be retired
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 used per police report.

OCCUPANT INJURIES - 2005 Cadillac Escalade

Driver: Injuries obtained from the driver interview.

<u>Injury</u>	<u>OIC Code</u>	<u>Injury Mechanism</u>	<u>Confidence Level</u>
Laceration (minor), forehead	290602.1,7	Windshield	Probable
Contusion, forehead	290402.1,7	Windshield	Probable
Contusion, left forearm	790402.1,2	Door panel	Probable

OCCUPANT KINEMATICS - 2005 Cadillac Escalade

Driver Kinematics

The 62-year-old male driver was seated in an upright posture. He was not wearing the manual 3-point lap and shoulder belt. The seat was adjusted to the rearmost track position and the seat back was slightly reclined at a 63 degree angle. The seat cushion had a 14 degree angle. He was wearing eyeglasses at the time of crash. Both hands were on the steering wheel at unknown o'clock positions. His left foot was on the floorboard. Just prior to impact, he began braking with his right foot. At the first impact, the driver pitched slightly forward and to the left. As the left rear tire was snagged, the vehicle began a sharp counterclockwise rotation. The unrestrained driver began moving to the right. At impact with the traffic signal pole, the driver came out of his seat and struck the center console with his hip and then struck the right side windshield with his head, causing the forehead laceration. As the vehicle rolled over onto its right side, the driver came to rest on the right side door. The driver was able to climb out of the side window unaided. Emergency personnel arrived on scene shortly after the crash. The driver sustained a forehead laceration that required three stitches, a small laceration on the right side of the forehead, and a contusion to the left forearm. He was transported by ambulance to a Level 1 trauma center where he was treated and released.



Figure 9. Driver's seated position

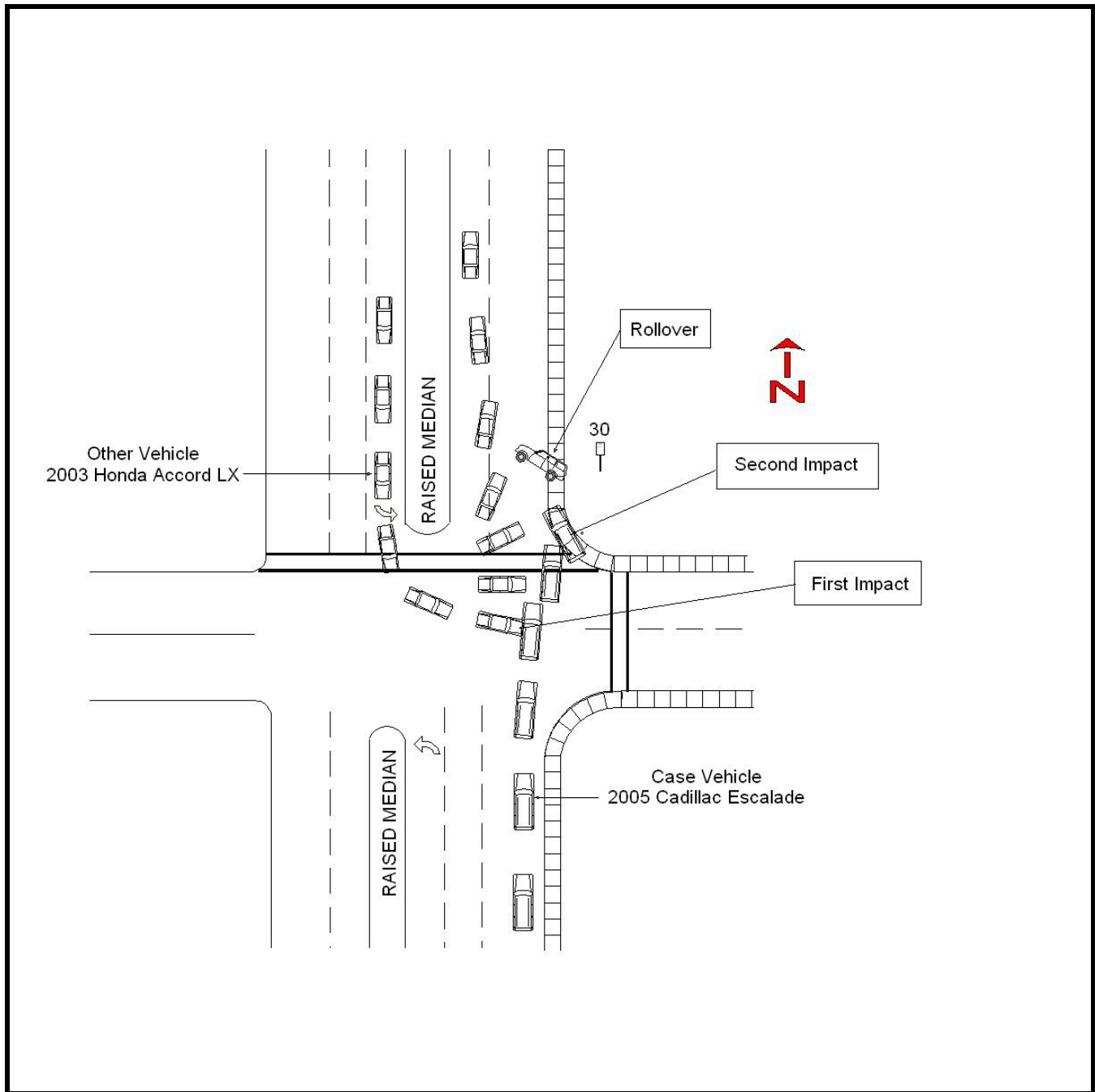


Figure 10. Right side windshield contact



Figure 11. Driver path to final rest

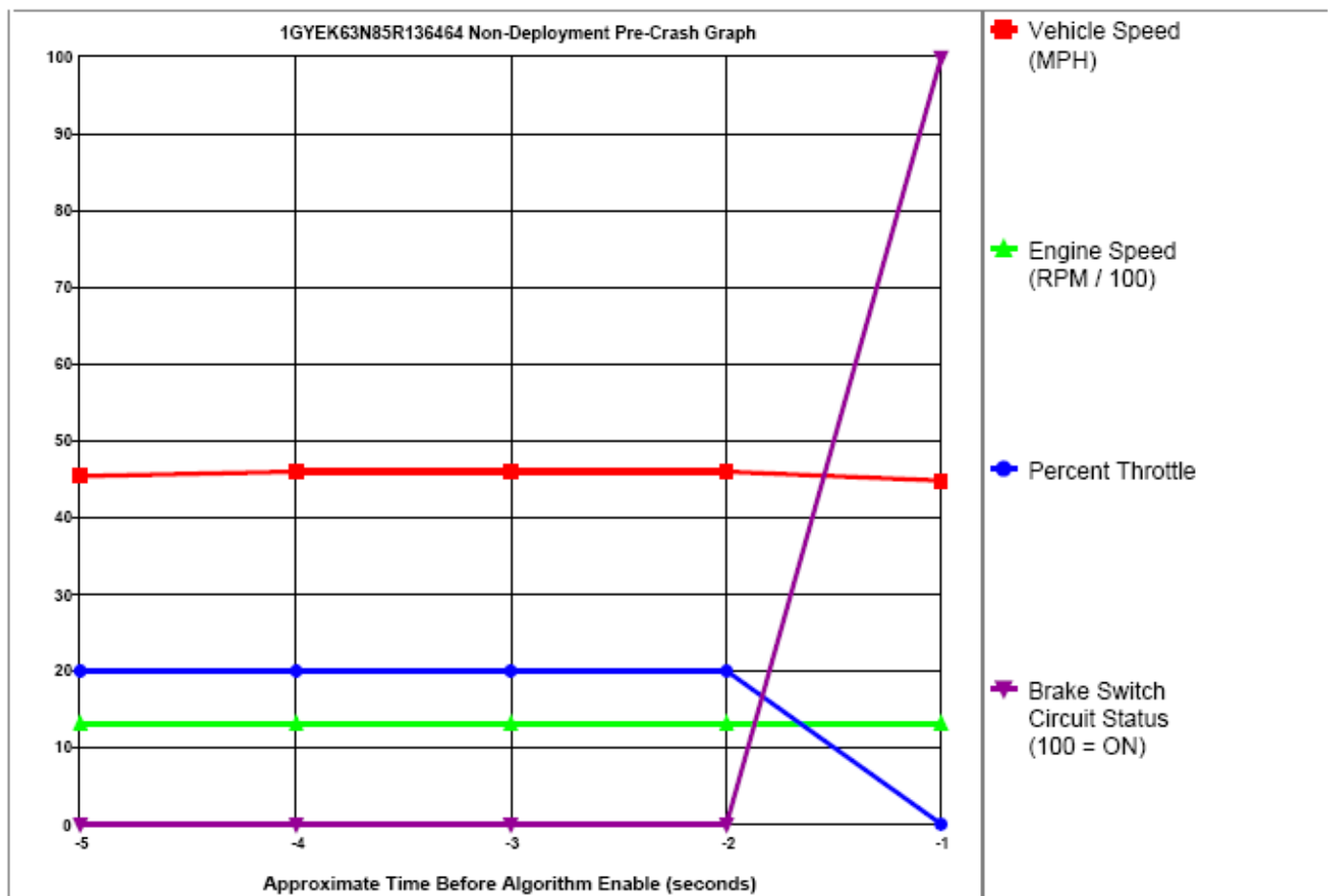
Attachment 1. Scene Diagram



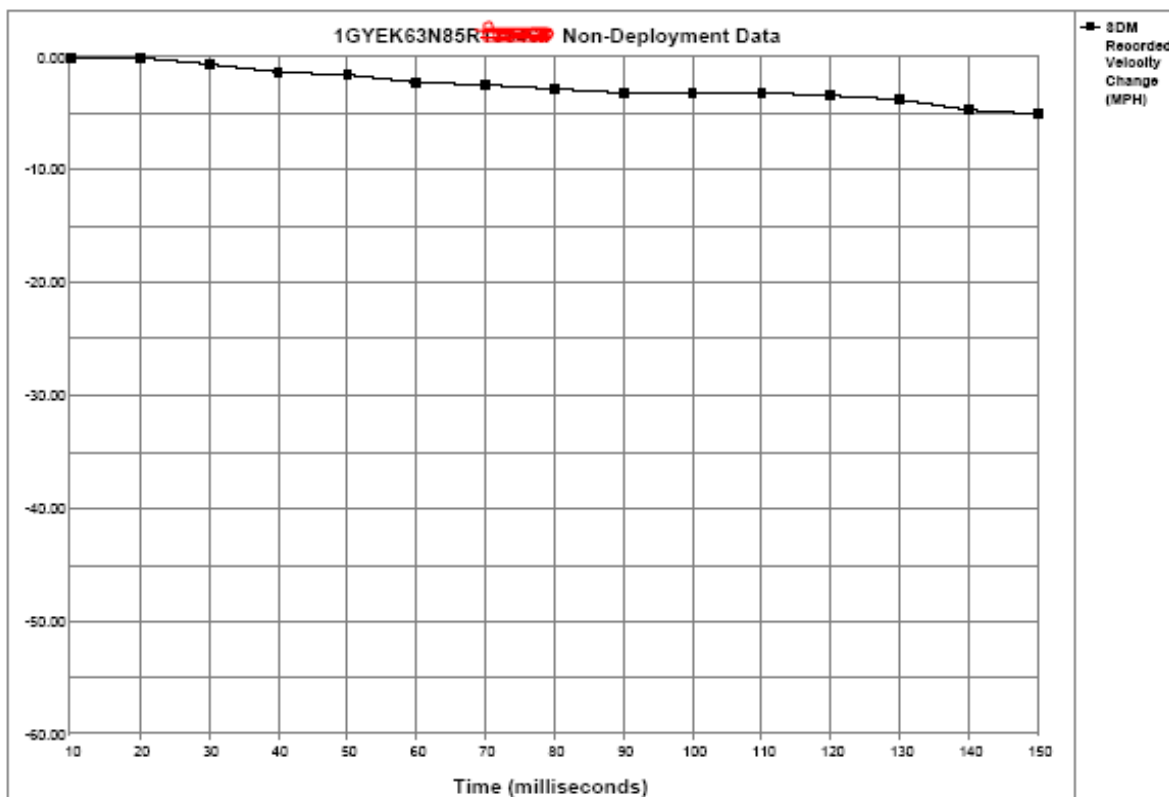
Attachment 2. Vetronix Report

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	3173
Ignition Cycles At Investigation	3183
Maximum SDM Recorded Velocity Change (MPH)	-5.88
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	220
Crash Record Locked	No
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	45	1280	20	OFF
-4	46	1280	20	OFF
-3	46	1280	20	OFF
-2	46	1280	20	OFF
-1	45	1344	0	ON



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	0.00	0.00	-0.62	-1.24	-1.55	-2.17	-2.48	-2.79	-3.10	-3.10	-3.10	-3.41	-3.72	-4.65	-4.96