On-Site Rollover Investigation
Dynamic Science, Inc. (DSI), Case Number DS08032
2007 Chevrolet C1500 Silverado
California
July 2008

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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 on-site rollover investigation focused on the dynamics of a 2007 Chevrolet C1500 Silverado pickup truck that was involved in a vehicle-to-vehicle crash and a rollover. The other vehicle was a 2007 Ford Fusion sedan. The crash occurred on a five-lane north/south roadway. The Chevrolet was occupied by a driver and front right passenger, and was traveling southbound. The Ford was occupied by a driver and a front right passenger, and was traveling northbound. The driver of the Ford reportedly fell asleep. The Ford departed the northbound lane over the left lane line, crossed the center turn lane, and the front end of the Ford impacted the left side of the Chevrolet. The Chevrolet was displaced to the right, traveled to the west curb, and impacted a curb and a sign post. The vehicle then tripped, overturned two quarter turns with its right side leading, and came to rest on its roof. During the crash, the left and right side curtain air bags deployed. The Ford traveled to the west curb, impacted the curb and a small tree, and came to rest at the curb.

The driver and passenger of the Chevrolet sustained minor injuries and the driver and passenger of the Ford sustained non-incapacitating injuries. Both vehicles were towed due to damage and the Chevrolet was later declared a total loss by the insurance company.

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Dynamic Science, Inc.
Crash Investigation
Case Number: DS08032

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Background

This on-site rollover investigation focused on the dynamics of a 2007 Chevrolet C1500 Silverado pickup truck that was involved in a vehicle-to-vehicle crash and a rollover (**Figure 1**). The other vehicle was a 2007 Ford Fusion sedan. The crash occurred on a five-lane north/south roadway. The Chevrolet was occupied by a driver and front right passenger, and was traveling southbound. The Ford was occupied by a driver and a front right passenger, and was traveling northbound. The driver of the Ford reportedly fell asleep. The Ford departed the northbound lane over the left lane line, crossed the center turn lane, and the front end of the Ford impacted the left side of the Chevrolet. The Chevrolet was displaced to the right, traveled to the west curb, and impacted a curb and a sign post. The vehicle then tripped, overturned two quarter turns with its right side leading, and came to rest on its roof. During the crash, the left and right side curtain air bags deployed. The Ford traveled to the west curb, impacted the curb and a small tree, and came to rest at the curb.

Figure 1. Subject vehicle, 2007 Chevrolet C1500 Silverado

The driver and passenger of the Chevrolet sustained minor injuries and the driver and passenger of the Ford sustained non-incapacitating injuries. Both vehicles were towed due to damage and the Chevrolet was later declared a total loss by the insurance company.

This on-site rollover investigation was initiated by the National Highway Traffic Safety Administration (NHTSA) during a review of police accident reports. On September 9, 2008, DSI was forwarded the police report and requested to obtain cooperation. On September 17, 2008, DSI obtained permission to inspect the subject vehicle, which was located at an insurance auction lot. The case was assigned on September 18, 2008, and the subject vehicle was inspected on September 22, 2008. The Chevrolet was equipped with an Event Data Recorder (EDR) that was supported by the Vetronix Crash Data Retrieval (CDR) system and the crash data was imaged as part of the vehicle inspection. The Ford was not inspected.

Summary

Crash Site

The crash site was a five-lane north/south roadway that included two lanes in each direction and a two-way center left turn lane (**Figure 2**). The two-way left turn lane was 3.1 m (10.2 ft) in width, the inboard lanes were 3.5 m (11.6 ft) in width, and the outboard lanes were 4.4 m (14.5 ft) in width. The roadway composition was asphalt, the alignment was straight, and the profile was level. Bordering the roadway on the east and west were raised concrete curbs that measured 20 cm (8.0 in) in height. The roadside environment consisted of level ground, small trees, and paved sidewalks. The crash occurred during daylight at 0650 hours, the weather was cloudy and the roadway was dry.

Streetlights were present but not illuminated. The posted speed limit was 56 km/h (35 mph).

Figure 2. Crash site, southbound approach

Pre-Crash

The Chevrolet was being driven southbound in the inboard lane by a 28-year-old male. A 40-year-old male occupied the front right seat position. The EDR reported the Chevrolet's pre-crash speed as 60 km/h (37 mph) at -1 second prior to AE; the throttle was actuated 16 percent, and the brake circuit switch was "ON."

The Ford was being driven northbound in the inboard lane by a 27-year-old male. A 29-year-old female occupied the front right seat position. The Ford departed the northbound lane across the left lane line, crossed the center turn lane and into the path of the Chevrolet. The driver of the Chevrolet observed the approach of the Ford and alerted his passenger. The driver of the Chevrolet steered to the right as an avoidance maneuver and began braking approximately 2 seconds prior to impact.

Crash

The crash sequence included seven events. The front left corner of the Ford contacted the left side of the Chevrolet (Event 1). The impact displaced the Chevrolet to the right and the vehicle rotated counterclockwise approximately 90 degrees. The right rear tire of the Chevrolet impacted the west curb (Event 2), the undercarriage impacted the curb and sidewalk (Event 3), and the right side impacted a steel sign post (Event 4). The vehicle's right side tires then tripped on the roadway and the vehicle initiated a right side leading rollover (Event 5). The vehicle rolled two quarter-turns and came to rest on its roof and facing east at the west curb.

The Ford initiated a post-impact counterclockwise rotation and traveled to the west curb. The vehicle's front end first impacted the curb (Event 6), and then a small tree (Event 6). The tree was knocked down and had been replaced prior to the scene inspection. Based on the size of the other trees in the area, the impacted tree was determined to be approximately 5 cm (1.9 in) in diameter. The Ford came to rest at the curb, facing southwest.

The vehicle-to-vehicle event resulted in the highest Delta-V among the five events sustained by the Chevrolet. Using only the Chevrolet's crush profile, the Missing Vehicle algorithm of the WinSMASH program computed a Total Delta-V of 10 km/h (6 mph); the longitudinal and lateral components were -9 km/h (-6 mph) and 3 km/h (2 mph), respectively. Considering the absence of the Ford's crush profile, these results should be considered as a borderline representation of the crash.

For the Ford, the Total Delta-V of 17 km/h (11 mph); the longitudinal and lateral components were -17 km/h (-11 mph) and 0 km/h, respectively.

Post-Crash

The driver of the Chevrolet unbuckled his safety belt and exited the vehicle without assistance through the front row left side window opening. The front right occupant did likewise through the front row right window opening.

The driver of the Chevrolet sustained and abrasion to the right elbow, a contusion to the left eye, and he complained of pain to the head. The front row right passenger sustained a minor laceration to the right hand. The driver of the Ford was reported by police to have complained of pain to the right knee, and the front passenger complained of pain to the left rib cage. None of the occupants were transported to a medical facility. The driver and front right occupant of the Chevrolet did not seek medical treatment. The occupants of the Ford were reported by police to have sought treatment later. Both vehicles were towed due to damage and the Chevrolet was later declared a total loss.

Vehicle Data - 2007 Chevrolet C1500 Silverado

The Chevrolet was identified by the Vehicle Identification Number (VIN): 2GCEC190571xxxxxx. The vehicle's date of manufacture was June 2007 and the electronic odometer reading was 10,655 miles (17,147 km). The vehicle was equipped with a 5.3-liter, 8-cylinder engine, automatic transmission, rear-wheel drive, 4-wheel standard anti-lock braking system (ABS), and standard daytime lights.

The Chevrolet was an E85 FlexFuel model that was designed to run on either gasoline, E85 ethanol, or a combination of both. E85 ethanol is a biofuel that consists of up to 85% ethanol mixed with gasoline. The fuel system was configured with a single nonmetallic fuel tank.

The vehicle manufacturer's recommended tire size was P275/55R20 for the front and the rear and the recommended cold tire pressure was 207 kPa (30 psi). The vehicle was equipped with Goodyear Eagle LS-2 P275/55R20 tires that had a tire manufacturer's recommended maximum tire pressure rating of 303 kPa (44 psi). The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	228 kPa (33 psi)	6 mm (7/32 in)	No	None
LR	Tire flat	7 mm (9/32 in)	No	Bead gouged, sidewall abraded
RR	Tire flat	7 mm (9/32 in)	No	Sidewall gouged, holed, torn
RF	241 kPa (35 psi)	6 mm (7/32 in)	No	None

The Chevrolet's interior was configured with seating for six occupants. The front row seating consisted of bucket seats for the outboard positions and a box-mounted seat with a folding back for the center position. The outboard seats were equipped with adjustable head restraints and the center seat had no head restraint. The center seat back folded forward and doubled as a console and

armrest. The second row seating consisted of a split bench seat with folding backs and adjustable head restraints for the three seating positions.

Vehicle Damage

Exterior Damage

The Chevrolet sustained direct and induced damage to the left and right sides, back end, undercarriage and top. The vehicle-to-vehicle impact resulted in damage to the left side and the direct damage began at 164 cm (64.6 in) aft of the front axle and extended rearward 293 cm (115.4 in). The Field L began at 175 cm (68.9 in) aft of the front axle, extended rearward 290 cm (114.2 in), and ended at the back left bumper corner. The left rear tire and rim were displaced from the vehicle during the impact and the rear axle was deformed. Damage to the tire included holes in the tread and sidewall; the rim was fractured along the perimeter of the flange. The Chevrolet's undercarriage deposited two parallel gouge marks in the pavement that measured 22 cm (8.7 in) and 28 cm (11.0 in) in length and were 46 cm (18.1 in) apart.

Six crush measurements were taken at mid-door level as follows: C1 = 14 cm (5.5 in), C2 = 7 cm (2.8 in), C3 = 4 cm (1.6 in), C4 = 17 cm (6.7 in), C5 = 5 cm (2.0 in), C6 = 0 (**Figure 3**). Maximum lateral crush was located at C4 and the Collision Deformation Classification (CDC) for the first impact was 11LZEW2.

Figure 3. Crush measurement to left side

The vehicle-to-vehicle impact resulted in side impact damage to the front left door. The height of maximum door crush was 59 cm (3.5 in), the sill height was 42 cm (16.5 in), and the Door Sill Differential (DSD) was 11 cm (4.3 in).

After the first impact, the vehicle rotated counterclockwise, traveled to the south curb, and the right rear tire contacted the curb. The tire deposited rubber transfers on the curb and the rim deposited a gouge in the pavement that measured 6.1 m (20.0 ft) in length. The tire sidewall was abraded and the rim was fractured. The CDC for the tire impact was 03RBWN1.

During the curb impact, the vehicle's rear undercarriage contacted the curb and paved sidewalk in a swiping impact that deposited scratches to the concrete. The direct damage to the undercarriage included surface scratching and other overlapping damage. The CDC for the undercarriage impact was 00UBDS01.

The vehicle's right side impacted a steel sign post that the police reported to be knocked over. The post measured 5 cm (2 in) square and was cut off at ground level at the time of the scene inspection. Based on scene evidence, the sign post probably was contacted by the vehicle's right rear section. The estimated CDC for the pole impact was 99RB9N9.

While traveling laterally in a yaw type skid along the curb, the vehicle's right side tires engaged the

roadway with sufficient force to induce a right side leading trip-over. The vehicle rolled two quarter-turns and came to rest on its roof.

The rollover resulted in contact and induced damage to the vehicle's right side and roof. Direct damage to the right side began at the front right bumper corner, extended rearward 443 cm (174.4 in), and ended at the back right bumper corner. Vertically, the direct damage began at mid-door level and extended upward 89 cm (35.0 in) to the right roof side rail.

Direct damage to the roof began at the windshield header and extended rearward 147 cm (57.9 in). The direct damage was distributed laterally across the roof from side rail to side rail and measured 130 cm (51.2 in) in width. The maximum lateral crush sustained in the rollover was located at the top of the A-pillar and measured 8 cm (3.2 in). The maximum vertical crush was located on the left roof, 20 cm (7.9 in) aft of the windshield header and 22 cm (8.7 in) inboard of the left roof side rail, and measured 15 cm (5.9 in). The CDC for the rollover was 00TPDO03.

Interior Damage

The Chevrolet sustained moderate interior damage as a result of passenger compartment intrusions. The windshield was cracked and the left rear and right front side glass was disintegrated. The windshield header, roof, left A-pillar, and the left roof side rail intruded into the front row of the passenger compartment. The rear view mirror was displaced from the windshield.

Manual Restraints

The Chevrolet was equipped with 3-point manual lap and shoulder belts for the front row outboard seating positions and they were configured with retractor pretensioners. The center seat was equipped with a manual lap belt with a locking latch plate and no pretensioner. The driver's safety belt was equipped with an adjustable D-ring anchorage that was in the full-up position. The belt webbing was slightly frayed along the edges where it contacted the D-ring and the latch plate was scratched indicating historical usage. The belt was equipped with an Emergency Locking Retractor (ELR). The belt and buckle exhibited no signs of occupant loading. The belt retractor had actuated during the crash and the belt was locked in the used position. The EDR reported the Driver's Belt Switch Circuit Status "BUCKLED", and the Driver Pretensioner Deployment Loop Commanded "YES." Based on evidence of historical usage, the EDR data and occupant kinematics, the front row left safety belt was determined to have been used to restrain the driver during the crash.

The front row passenger's safety belt was equipped with an adjustable D-ring anchorage that was in the full-down position. The belt webbing was slightly frayed along the edges from contact with the D-ring and the sliding latch plate was scratched indicating historical usage. The belt was equipped with an ELR/Automatic Locking Retractor. The belt and buckle exhibited no signs of occupant loading. The belt retractor had actuated during the crash and the belt was locked in the used position. The EDR reported the Passenger's Belt Switch Circuit Status "BUCKLED", and the Passenger Pretensioner Deployment Loop Commanded "YES." Based on evidence of historical usage, the EDR data and occupant kinematics, the front row right safety belt was determined to have been used to restrain the occupant during the crash.

The second row seats were equipped with 3-point manual lap and shoulder belts. The outboard belts

were equipped with non-adjustable anchorages on the C-pillars. The center belt anchorage was integrated into the seat back. The three safety belts were equipped with switchable ELR/ALR. The safety belt latch plates were slightly scratched indicating historical usage.

Supplemental Restraint System

The Chevrolet's Event Data Recorder (EDR) was imaged by the SCI Investigator and the Vetronix report with the hexidecimal data deleted is included as Attachment 2 at the end of this report. The Chevrolet's Supplemental Restraint System (SRS) included a Sensing Diagnostic Module (SDM), driver and passenger frontal air bags, head impact side curtain air bags, front and side impact sensors, and front row outboard position retractor safety belt pretensioners. The primary function of the SDM is to control the deployment of the SRS. For Deployment Events and Deployment Level Events, the SDM will record 220 milliseconds (msec) of data after deployment criteria are met and 70 msec before deployment criteria is met. For Non-Deployment Events, the SDM will record up to the first 300 msec of data after Algorithm Enable (AE).

Two events were recorded by the SDM: The recorded deployment event was the rollover; the recorded non-deployment event was probably related to the rollover, based on the long AE to maximum SDM recorded velocity change of 660 ms; the non-recorded event was not determined.

The Vetronix System Status At AE was as follows:

1. Low Tire Pressure Warning Lamp was "OFF".
2. Vehicle Pre-crash Speed at -2.5 sec was 63 km/h (39 mph).
3. Vehicle Pre-crash Speed at -0.5 sec was 56 km/h (35 mph).
4. Vehicle Engine Speed at -2.5 sec was 1664 cycles
5. Vehicle Engine Speed at -0.5 sec was 960 cycles.
6. Brake Switch Circuit Status at -2.5 sec was "OFF".
7. Brake Switch Circuit Status at -0.5 sec was "ON".

The Vetronix System Status At Deployment was as follows:

1. Driver's Belt Switch Circuit Status was "BUCKLED".
2. Passenger's Belt Switch Circuit Status was "BUCKLED".
3. Driver Seat Position Switch Circuit Status was "Rearward".
4. Passenger Air Bag Indicator Status at Event Enable was "ON".
5. Driver/Passenger Roof Rail/Head Curtain Time From AE to Deployment Command Criteria Met (msec) was 637.5.
6. Side Air Bag Deployment Status Due to Rollover Commanded was "Side Air Bag(s) Were First Commanded to Deploy Due to Rollover Event".
7. Rollover Sensor Status was "Rollover Event".
8. Time From Rollover Event Enable to Deployment (msec) was 680.
9. Time Between Events (sec) was .04.
10. Driver/Passenger Pretensioner Deployment Loop Command was "Yes".

The Vetronix System Status At Non-Deployment was as follows:

1. AE to Maximum SDM Recorded Velocity Change (msec) was 660.
2. Maximum SDM Recorded Velocity Change (msec) was 3.64.
3. Time Between Events (sec) was .08.

The vehicle's frontal air bags were advanced dual-stage Certified Advanced 208-Compliant (CAC). The air bags were certified by the manufacturer be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The driver's air bag was located in the steering wheel hub and the passenger's air bag was located in the top instrument panel. The frontal air bags did not deploy during the crash.

The vehicle's side curtain air bags were monitored by a rollover sensor and deployed during the rollover event from the left and right roof side rails (**Figure 4**). They were designed to provide impact protection to outboard positioned occupants during both rollover and side impacts and reduce the chance of occupant ejection. The side curtain air bags were constructed of smooth coated nylon material, were generally rectangular in shape, and measured 155 cm (61 in) in length and 59 cm (23.2 in) in height. At the leading end, a woven nylon sail measuring 25 cm (9.8 in) in length connected the side curtain air bags to the A-pillars. At the trailing end of the bag a tether attached the air bags to the C-pillars. They were designed without vent ports.

Figure 4. Deployed left side curtain air bag

The side curtain air bag's area of coverage included the front and second row side windows; vertically, the coverage extended from the roof side rail to the mid-door level. The left side curtain air bag was not damaged and revealed no occupant contacts. Dried beverage splatter was present on the inboard panel in the upper forward quadrant adjacent to the driver's seat. The right side curtain air bag was not damaged and revealed no occupant contacts. Dried beverage splatter was present on the inboard aspect of the bag in the upper forward quadrant near the A-pillar.

Rollover

The Chevrolet had a Static Stability Factor (SSF) of 1.19. The SSF of a vehicle is an at-rest calculation of its rollover resistance, which is based on its track width and center of gravity. The Chevrolet had a rollover resistance rating of 4 out of 5 stars, and the vehicle had a chance of rollover of 19 %.[1] The vehicle was equipped with rear wheel drive, a 4-wheel Assisted Braking System (ABS), 4-wheel anti-lock brakes, and a tire pressure monitoring system. Traction control was not available on this make/model.

The Chevrolet was equipped with an Electronic Stability Control (ESC) system that was designed

[1] Safercar.gov

to help improve stability on slick surfaces and during emergency maneuvers. The system utilizes a control module that measures the vehicle's steering wheel angle, wheel speed, and brake pressure. The system works by comparing driver input with the vehicle's actual steering arc, and then applying individual brake pressure and adjusting engine torque when necessary. Just prior to impact, the driver of the Chevrolet steered right and braked. It is probable that during the crash sequence the ESC activated in response to driver input and the vehicle dynamics. However, due to the post-impact rotation and yaw of the Chevrolet and the displacement of the left rear wheel, the ESC had little effect on the vehicle's stability prior to the rollover.

After the vehicle-to-vehicle impact, the Chevrolet initiated a sharp counterclockwise rotation and the left rear wheel was displaced from the vehicle. The vehicle contacted the west curb, and was redirected into a lateral direction of travel. The vehicle rotated approximately 90 degrees between the first impact and the trip point. Due to the vehicle's rotation and the loss of its left rear wheel, the effects of braking and steering were compromised. Scrape, gouge and tire marks deposited on the area of the curb were evidence of the vehicle's travel path prior to the rollover. The field of evidence was roughly 8 m (19.8 ft) in length and comprised the roadway, curb and sidewalk. The gouges in the roadway were deposited by the vehicle's right rear rim; the scrapes to the sidewalk were deposited by the undercarriage; the rubber transfers on the curb were deposited by the right rear tire. Just prior to the rollover, the vehicle's right rear corner and bumper contacted and knocked over a steel sign post located 1 m (3.4 ft) west of the west curb. The impact to the sign post was a low Delta-V event that had minimal impact on the rollover dynamics of the vehicle.

As the vehicle traveled laterally along the curb, the right side tires engaged the roadway and the vehicle initiated a right side leading trip-over. The vehicle came to rest on its roof and facing east. Based on the scene evidence and vehicle damage, the estimated rollover distance was 5 m (16.4 ft).

Vehicle Data - 2007 Ford Fusion

The Ford's VIN was unknown. The vehicle was a 4-door sedan equipped with seating for five occupants. The vehicle's tire data was unknown. After the crash, the 27-year-old driver complained of pain to the right knee but refused medical treatment at the scene. The 29-year-old female occupant complained of pain to the left ribs but refused treatment at the scene. The police reported the vehicle to have sustained severe damage to the front right corner. The vehicle was towed from the scene due to damage.

Occupant Demographics - 2007 Chevrolet C1500 Silverado

	Driver	Occupant 2
Age/Sex:	28/Male	40/Male
Seated Position:	Front left	Front right
Height:	180 cm (71 in)	183 cm (72 in)
Weight:	93 kg (205 lb)	98 kg (216 lb)
Seat Type:	Bucket	Bucket
Seat Track Position:	Mid-track	Mid-track
Manual Restraint Usage:	Lap and shoulder belt	Lap and shoulder belt
Usage Source:	Vehicle inspection	Vehicle inspection
Air bags:	Side curtain air bag deployed	Side curtain air bag deployed
Alcohol/Drug Involvement:	None	None
Type of medical treatment:	None	None

Kinematics

Driver Kinematics

The 28-year-old male driver was seated in an upright posture and was restrained by the vehicle's 3-point manual lap and shoulder belt. He was actively steering the vehicle with his left hand and his right arm was resting on the center armrest. His right foot was on the accelerator and his left foot was on the floor. The vehicle was traveling at approximately 63 km/h (39 mph).

Just prior to impact the driver observed the Ford traveling toward the Chevrolet, steered right, and moved his right foot from the accelerator and applied the brakes. The front end of the Ford impacted the left side of the Chevrolet. At impact, the driver was displaced forward and to the left, in response to the 11 o'clock direction of force. The driver loaded the safety belt although no loading evidence was found.

The Chevrolet initiated a post-impact counterclockwise rotation and was displaced to the right. The Chevrolet's right side tires tripped on the roadway and the vehicle initiated a two quarter-turn rollover with its right side leading. During the rollover, the driver's safety belt pretensioner actuated and the left side curtain air bag deployed. During the first quarter turn, the driver was displaced to the right but was held in his seat by the safety belt. He sustained an abrasion to the right elbow from an undetermined source. The driver sustained a contusion to the left eye and during the interview he stated his face possibly contacted the left side curtain air bag; however, the air bag revealed no evidence of occupant contact. The driver refused medical treatment at the scene, was not transported, and did not seek treatment later. He did not miss any work due to his injuries.

Front Row Right Occupant Kinematics

The 40-year-old male occupant was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. His arms were at his sides and his feet were on the floor. At impact, he was displaced forward and to the left in response to the direction of force.

During the rollover, the passenger's safety belt pretensioner actuated and the right side curtain air bag deployed. The occupant was displaced to the right, but was held in his seat by the safety belt. The right side glass disintegrated and the passenger was contacted by the flying glass. The occupant sustained a minor laceration to the right hand and it is probable the flying glass was the mechanism for this injury. During the second quarter turn, the vehicle was upside down and the occupant's lower extremities probably contact the lower IP although no contact evidence was documented.

The front right occupant refused medical treatment at the scene, was not transported, and did not seek treatment later. He did not miss any work due to his injury.

Injuries

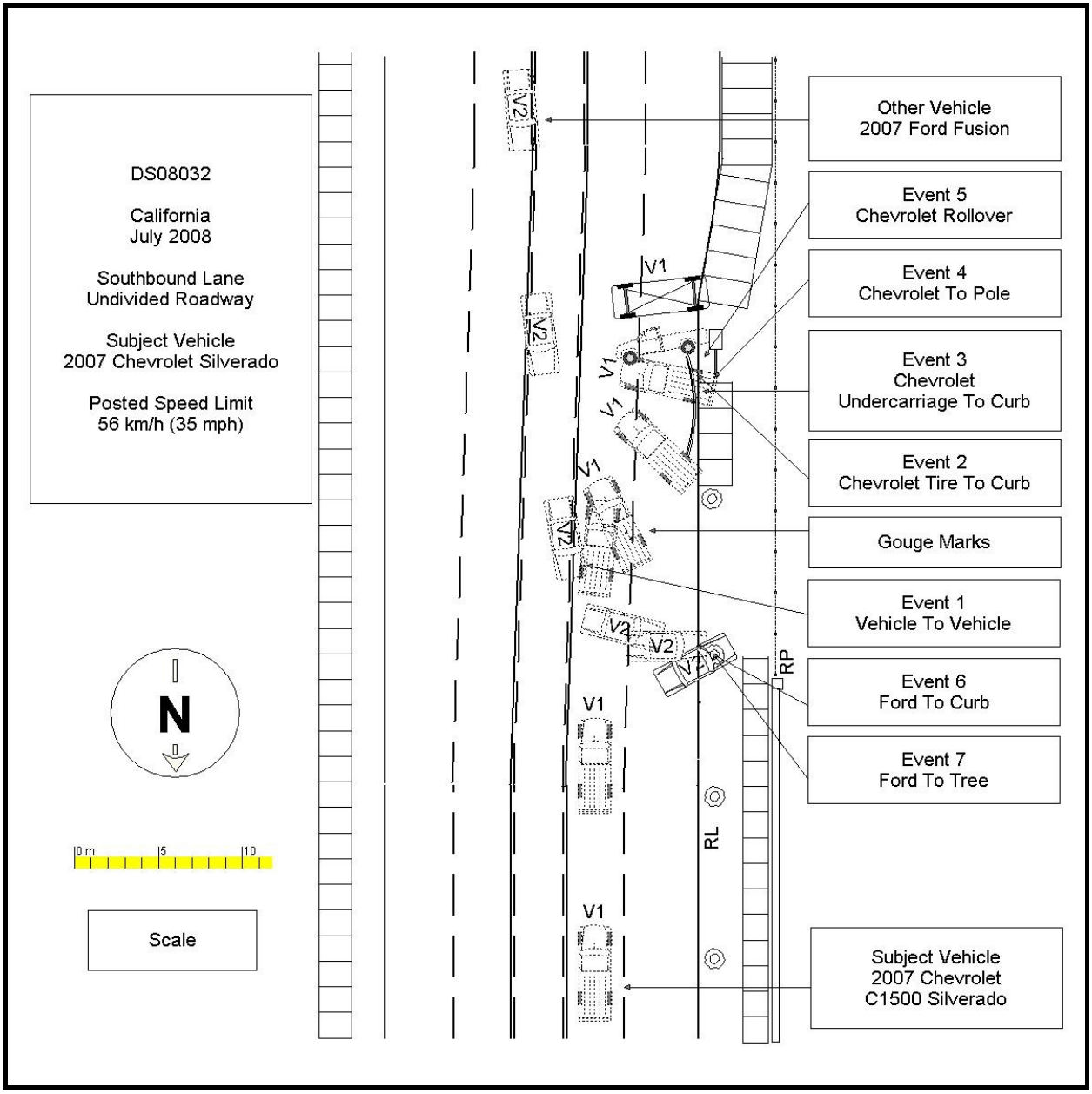
Driver
Injuries data obtained from interview.

Injury	OIC Code	Injury Mechanism	Confidence Level
Contusion, left eye	297402.1,2	Air bag	Possible
Abrasion, right elbow	790202.1,1	Unknown	Unknown

Occupant 2
Injury data obtained from interview.

Injury	OIC Code	Injury Mechanism	Confidence Level
Laceration, minor, left hand	790602.1,1	Flying glass	Probable

Attachment 1. Scene Diagram



Attachment 2. Vetronix CDR Report

CDR File Information

Vehicle Identification Number	2GCEC19057******
Investigator	
Case Number	DS08032
Investigation Date	Monday, September 22 2008
Crash Date	Wednesday, July 9 2008
Filename	08032 WO VIN.CDR
Saved on	Monday, September 22 2008 at 09:52:26 AM
Collected with CDR version	Crash Data Retrieval Tool 2.900
Reported with CDR version	Crash Data Retrieval Tool 2.900
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). The minimum SDM Recorded Vehicle Forward Velocity Change, that is needed to record a Non-Deployment Event, is 5 MPH. It can contain Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by a Deployment Level Event, if the Non-Deployment Event is not locked. This event will be cleared by the SDM, after 250 ignition cycles.
The second type of SDM recorded crash event is the Deployment Event. It also can contain Pre-Crash and Crash data. The SDM can store up to two different Deployment Events. 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 Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event. If a Deployment Level Event occurs any time after the Deployment Event, the Deployment Level Event will overwrite any non-locked Non-Deployment Event.

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 Deployment Events and Deployment Level Events, the SDM will record 220 milliseconds of data after deployment criteria is met and up to 70 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM will record up to the first 300 milliseconds of data after algorithm enable. The minimum SDM Recorded Vehicle Forward Velocity Change, that is needed to record a Non-Deployment Event, is 5 MPH.
-Maximum Recorded Vehicle Velocity Change is the maximum recorded velocity change in the vehicle's combined "X" and "Y" axis.
-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 receive an invalid message from the module sending the pre-crash data.
-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the 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 5 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.
-The ignition cycle counter relies upon the transitions through OFF->RUN->CRANK power-moding messages, on the GMLAN communication bus, to increment the counter. Applying and removing of battery power to the module will not increment the ignition cycle counter.
-Driver and Passenger Pretensioner Deployment Loop Commanded data will be displayed as "No", if they were the only restraint device commanded to be deployed in an event.

SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Status Data (Pre-Crash) is transmitted to the SDM, by various vehicle control modules, via the vehicle's communication network.
-The Belt Switch Circuit is wired directly to the SDM.

Multiple Event Data

Associated Events Not Recorded	1
An Event(s) Preceded the Recorded Event(s)	No
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	Yes
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	Yes

System Status At AE

Low Tire Pressure Warning Lamp (If Equipped)	OFF
Vehicle Power Mode Status	Run
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active

Pre-crash data

Parameter	-1.0 sec	-0.5 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No
Engine Torque (foot pounds)	185.14	179.24

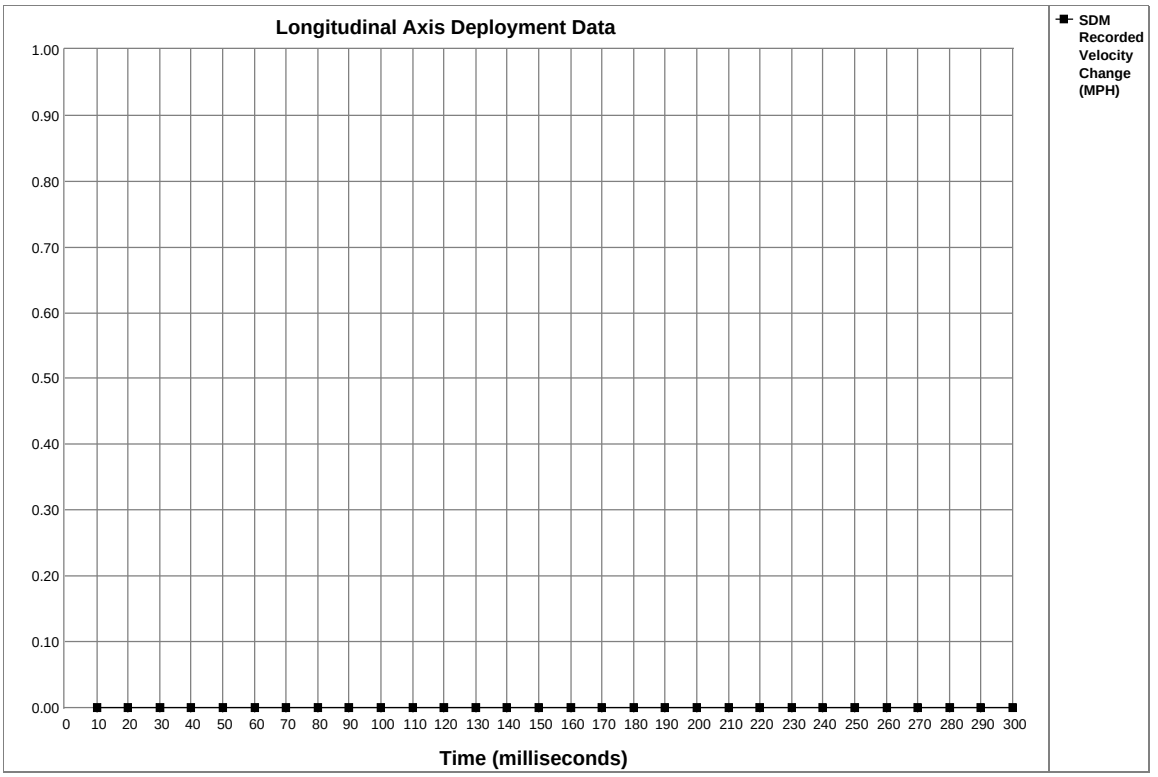
Pre-crash data

Parameter	-2.5 sec	-2.0 sec	-1.5 sec	-1.0 sec	-0.5 sec
Vehicle Speed (MPH)	39	39	40	37	35
Engine Speed (RPM)	1664	1536	1280	1088	960
Percent Throttle	36	31	18	16	16
Brake Switch Circuit Status	OFF	OFF	ON	ON	ON

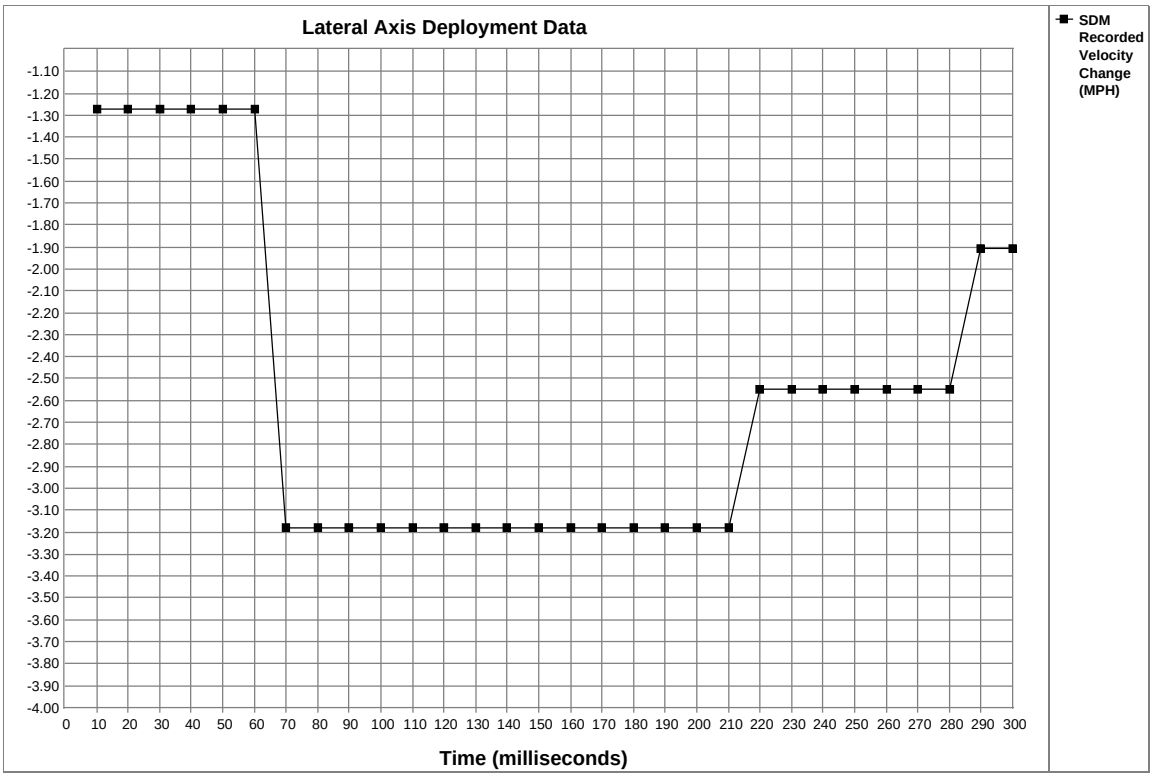
System Status At Deployment

Ignition Cycles At Investigation	3082
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/Off Time Continuously	190
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	0
Ignition Cycles At Event	3077
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	BUCKLED
Passenger's Belt Switch Circuit Status	BUCKLED
Driver Seat Position Switch Circuit Status	Rearward
Passenger Classification Status at Event Enable	Large Occupant Classification Type #1
Current Passenger Position Status at Event Enable	Unknown
Previous Passenger Position Status at Event Enable	Unknown
Passenger Air Bag Indicator Status at Event Enable	ON
Diagnostic Trouble Codes at Event, fault number: 1	N/A
Diagnostic Trouble Codes at Event, fault number: 2	N/A
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Diagnostic Trouble Codes at Event, fault number: 7	N/A
Diagnostic Trouble Codes at Event, fault number: 8	N/A
Diagnostic Trouble Codes at Event, fault number: 9	N/A
Driver 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Driver 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Passenger 1st Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Passenger 2nd Stage Time From Algorithm Enable to Deployment Command Criteria Met (msec)	N/A
Driver Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	637.5
Passenger Side or Roof Rail/Head Curtain Time From Algorithm Enable to Deployment Command Criteria Met (msec)	637.5
Rollover Occupant Containment Enable Status	Enabled
Side Air Bag Deployment Status Due to Rollover Commanded	Side Air Bag(s) Were First Commanded to Deploy Due to Rollover Event
Rollover Sensor Status	Rollover Event
Time From Rollover Event Enable to Deployment (ms)	680
Crash Record Locked	Yes
Vehicle Event Data (Pre-Crash) Associated With This Event	No
SDM Synchronization Counter	3077
Time Between Events (sec)	.04
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded for Disposal	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded for Disposal	No
Driver Pretensioner Deployment Loop Commanded	Yes
Passenger Pretensioner Deployment Loop Commanded	Yes
Driver Side Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Right Side Deployment Loop Commanded	No
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	Yes
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	Yes
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No

Second Row Left Pretensioner Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No



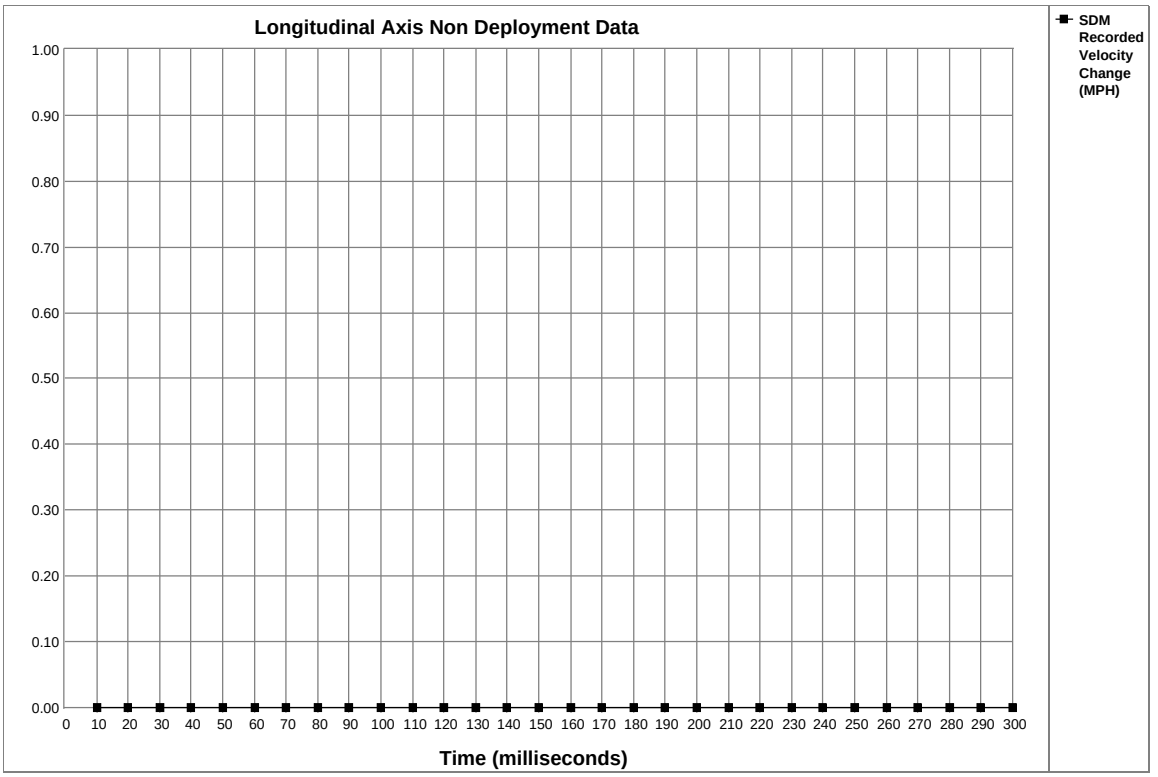
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Longitudinal Axis Recorded Velocity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Longitudinal Axis Recorded Velocity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



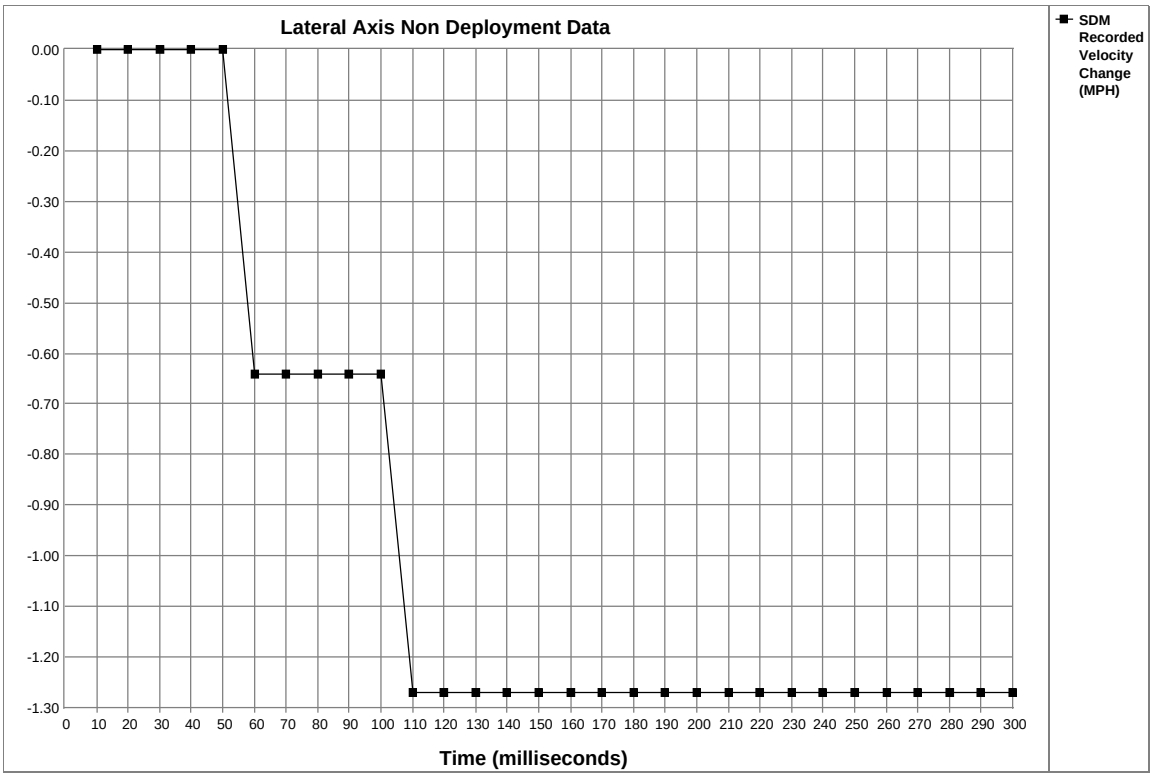
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Lateral Axis Recorded Velocity Change (MPH)	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-3.18	-3.18	-3.18	-3.18	-3.18	-3.18	-3.18	-3.18	-3.18
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Lateral Axis Recorded Velocity Change (MPH)	-3.18	-3.18	-3.18	-3.18	-3.18	-3.18	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-2.55	-1.91	-1.91

System Status At Non-Deployment

Ignition Cycles At Investigation	3082
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/Off Time Continuously	190
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	0
Ignition Cycles At Event	3077
Ignition Cycles Since DTCs Were Last Cleared	255
Driver's Belt Switch Circuit Status	BUCKLED
Passenger's Belt Switch Circuit Status	BUCKLED
Driver Seat Position Switch Circuit Status	Rearward
Diagnostic Trouble Codes at Event, fault number: 1	N/A
Diagnostic Trouble Codes at Event, fault number: 2	N/A
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Diagnostic Trouble Codes at Event, fault number: 7	N/A
Diagnostic Trouble Codes at Event, fault number: 8	N/A
Diagnostic Trouble Codes at Event, fault number: 9	N/A
Maximum SDM Recorded Velocity Change (MPH)	3.64
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	660
Crash Record Locked	Yes
Deployment Event Recorded in the Non-Deployment Record	No
Vehicle Event Data (Pre-Crash) Associated With This Event	No
SDM Synchronization Counter	3077
Time Between Events (sec)	.08
Event Recording Complete	Yes
Driver First Stage Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	No
Driver 2nd Stage Deployment Loop Commanded for Disposal	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger 2nd Stage Deployment Loop Commanded for Disposal	No
Driver Pretensioner Deployment Loop Commanded	No
Passenger Pretensioner Deployment Loop Commanded	No
Driver Side Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Right Side Deployment Loop Commanded	No
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 3) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Longitudinal Axis Recorded Velocity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Longitudinal Axis Recorded Velocity	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Lateral Axis Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	0.00	-0.64	-0.64	-0.64	-0.64	-0.64	-1.27	-1.27	-1.27	-1.27	-1.27
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Lateral Axis Recorded Velocity Change (MPH)	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27	-1.27