

**TRANSPORTATION SCIENCES
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**SCI 1 REMOTE CERTIFIED ADVANCED 208-COMPLAIANT VEHICLE CRASH
INVESTIGATION**

SCI 1 TECHNICAL SUMMARY REPORT

NASS/SCI COMBO CASE NO. 03-43-022G

VEHICLE – 2003 CHEVROLET SILVERADO

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE – JANUARY 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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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 are 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.

TECHNICAL REPORT STANDARD TITLE PAGE

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<i>16. Abstract</i> This remote investigation focused on the performance of the Certified Advanced 208-Compliant frontal air bag system in a 2003 Chevrolet Silverado. The manufacturer of this vehicle has certified that this 2003 Chevrolet Silverado meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system included dual stage frontal air bags, seat track position sensor for the front left and front right seats and an occupant detection sensor for the front right seat. In addition, the Silverado was equipped with an Event Data Recorder (EDR) that was downloaded by the NASS researcher. The 2003 Chevrolet Silverado was occupied by a restrained 33-year-old male driver and a restrained 28-year-old male front right occupant. The Silverado was involved in a minor severity intersection crash with a 2002 Freightliner Fleetwood motor home. The Freightliner was occupied by a 53-year-old female driver. The Silverado was traveling eastbound on a six lane divided roadway approaching an intersection. The Freightliner was traveling northbound on an intersecting roadway approaching the same intersection where the Freightliner turned left. The Freightliner failed to yield the right of way and turned left in front of the Silverado. The front left area of the Silverado impacted the left rear side aspect of the Freightliner in the intersection. The impact with the Freightliner did not result in the deployment of the Silverado's frontal air bags. The driver and front right passenger of the Silverado sustained police reported possible injuries, however, they refused medical treatment at the scene. The driver stated to the NASS researcher that he and the front right passenger sought treatment at a later time at a hospital. The driver's injuries consisted of bilateral knee contusions, and a bruised left foot. He was treated and released. The front right passenger's injuries consisted of a cervical spine strain and a bruised right knee. He was also treated for his injuries and released.		<i>13. Type of Report and Period Covered</i> Technical Report Crash Date: January 2003	
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**SCI 1 REMOTE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH
INVESTIGATION
SCI 1 SUMMARY TECHNICAL REPORT
NASS/SCI COMBO CASE NO. 03-43-022G
SUBJECT VEHICLE – 2003 CHEVROLET SILVERADO
LOCATION - STATE OF NORTH CAROLINA
CRASH DATE - JANUARY 2003**

BACKGROUND

This remote investigation focused on the performance of the Certified Advanced 208-Compliant frontal air bag system in a 2003 Chevrolet Silverado (**Figure 1**). The manufacturer of this vehicle has certified that this 2003 Chevrolet Silverado meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system included dual stage frontal air bags, seat track position sensor for the front left and front right seats and an occupant detection sensor for the front right seat. In addition, the Silverado was equipped with an Event Data Recorder (EDR) that was



Figure 1. 2003 Chevrolet Silverado.

downloaded by the NASS researcher. The 2003 Chevrolet Silverado was occupied by a restrained 33-year-old male driver and a restrained 28-year-old male front right occupant. The Silverado was involved in a minor severity intersection crash with a 2002 Freightliner Fleetwood motor home. The Freightliner was occupied by a 53-year-old female driver. The Silverado was traveling eastbound on a six lane divided roadway approaching an intersection. The Freightliner was traveling northbound on an intersecting roadway approaching the same intersection where the Freightliner turned left. The Freightliner failed to yield the right of way and turned left in front of the Silverado. The front left area of the Silverado impacted the left rear side aspect of the Freightliner in the intersection. The impact with the Freightliner did not result in the deployment of the Silverado's frontal air bags. The driver and front right passenger of the Silverado sustained police reported possible injuries, however, they refused medical treatment at the scene. The driver stated to the NASS researcher that he and the front right passenger sought treatment at a later time at a hospital. The driver's injuries consisted of bilateral knee contusions, and a bruised left foot. He was treated and released. The front right passenger's injuries consisted of a cervical spine strain and a bruised right knee. He was also treated for his injuries and released.

This crash was identified by the National Automotive Sampling System (NASS) PSU 43 during the weekly sampling of Police Accident Reports (PARs). This crash was selected and researched as CDS Case No. 03-43-022G. The NASS PSU performed the vehicle, scene inspections, and driver/occupant interviews. Due to the presence of an Advanced

208-Compliant vehicle, NHTSA assigned the tasks of case review and report preparation to the SCI 1 team.

SUMMARY

Crash Site

This two-vehicle crash occurred during the daylight hours of January 2003 in the state of North Carolina. At the time of the crash, there were no adverse weather conditions and the asphalt road surface was dry. The crash occurred at a “T” intersection of two local state roads. The eastbound roadway was a four-lane roadway that consisted of a left turn lane; two through lanes, and a right turn only lane. The east/westbound lanes were separated by a depressed grass median and were straight with a slight downhill grade at the intersection. A white fog line and an asphalt shoulder bordered the eastbound lanes. The northbound roadway was configured with one northbound and one southbound lane. The north/south roadway was straight with a downhill grade. Traffic flow through the intersection was controlled by a stop sign for northbound traffic. The posted speed limit for both roadways was 89 km/h (55 mph).

Vehicle Data – 2003 Chevrolet Silverado

The 2003 Chevrolet Silverado was identified by the Vehicle Identification Number (VIN): 1GCEK19TX3 (production sequence omitted). The odometer reading was 10,852 km (6,743 miles) at the time of the inspection. The vehicle was a four-door pick up truck that was equipped with a 5.3-liter, eight-cylinder engine, four-wheel disc brakes with ABS, four-wheel drive and a five-speed automatic transmission. The tires on the Silverado were Firestone Wilderness AT radials, size P265/75R16. The manufacture recommended front and rear tire pressure was 241 kpa (35 psi). The maximum pressure for the tires was 303 kpa (44 psi). The specific tire data is as follow:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	228 kpa (33 psi)	10 mm (13/32)	No	None
LR	228 kpa (33psi)	9 mm (11/32)	No	None
RF	228 kpa (33 psi)	10 mm (13/32)	No	None
RR	234 kpa (34 psi)	9 mm (11/32)	No	None

The Silverado was configured with front bucket seats with height adjustable head restraints. The second row was configured with a bench seat and height adjustable head restraints for the outboard positions.

2002 Freightliner Fleetwood Motor Home

The 2002 Freightliner Fleetwood motor home was identified by the Vehicle Identification Number (VIN): 4UZAAHBV12 (production sequence omitted). The vehicle was not inspected. The vehicle was large motor home that was manufactured with a Freightliner chassis with the body and accessories manufactured by Fleetwood. The motor home had a gross vehicle weight range of 11- 16,330 kgs (26-33,000 lbs).

Pre-Crash

The restrained 33-year-old male driver of the Chevrolet was operating the vehicle eastbound in the left through lane on approach to the “T” intersection (**Figure 2**). A restrained 28-year-old male front right occupant also occupied the Chevrolet. The driver of the Freightliner was operating the vehicle northbound on approach to the “T” intersection (**Figure 3**) where he was intending to turn left. The 53-year-old female driver of the Freightliner failed to detect the Chevrolet and turned left across the path of the Chevrolet. It was unknown if the driver of the Freightliner came to a complete stop before entering the intersection. There was no physical evidence at the crash site. The EDR data indicated the Chevrolet was traveling at 106.0 km/h (66.0 mph) five seconds prior to Algorithm Enable (AE) and had slowed to 51.5 km/h (32.0 mph) one second prior to AE. The EDR also indicated that the brake switch status was in the on-position from four to one second prior to the crash. The police reported travel speed for the Chevrolet was 89 km/h (55 mph) and 8 km/h (5 mph) for the Freightliner. The NASS scene schematic is included as **Figure 18** of this report.



Figure 2. Chevrolet's eastbound approach.

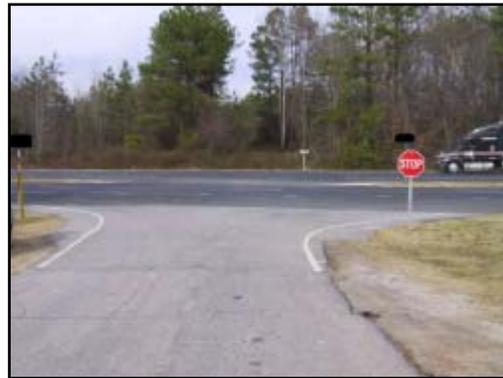


Figure 3. Freightliner's northbound approach.

Crash

The front left aspect of the Chevrolet impacted the rear left side aspect of the Freightliner (**Figure 4**) in the intersection. The impact resulted in minor severity damage to the front aspect of the Chevrolet and was not sufficient to deploy the frontal air bags. The WINSMASH program was used to calculate a barrier equivalent speed for this impact due to the Freightliner being out of scope for the WINSMASH program. The barrier equivalent speed for the Chevrolet was 10.0 km/h (6.2 mph). The EDR data recorded a maximum velocity change of -7.99 km/h (-4.97 mph).



Figure 4. Area of impact from Chevrolet's approach.

Post-Crash

Both vehicles came to rest within the intersection. The driver and front occupant of the Chevrolet were police reported as sustaining possible injury. They refused transport at the scene and went to the hospital later. The Chevrolet was towed from the scene. The Freightliner was not towed from the scene.

VEHICLE DAMAGE

Exterior – 2003 Chevrolet Silverado

The 2003 Chevrolet Silverado sustained minor severity frontal damage as a result of the intersection type crash with the Freightliner (Figure 5). The direct contact damage began on the front left bumper corner and extended left 25.0 cm (9.8”). The damage consisted of a longitudinally displaced bumper, hood and front left fender and a disintegrated front left headlight assembly. Six crush measurements were documented along the front bumper using a combined direct and induced damage with of 168.0 cm (66.1”) and were as follows: C1 = 7.0 cm (2.8”), C2 = 5.0 cm (2.0”), C3 = 2.0 cm (0.8”), C4 = 0.0 cm, C5 = 0.0 cm, C6 = 0.0 cm.



Figure 5. Chevrolet's crush profile.

The Collision Deformation Classification for this impact was 12-FLEE-1. The four doors remained closed and operational and all glazing remained intact.

Interior – 2003 Chevrolet Silverado

The 2003 Chevrolet Silverado sustained no interior damage (Figure 6 and 7) as a result of the crash.



Figure 7. Across instrument panel from left. No interior damage.



Figure 6. Across instrument panel from right. No interior damage.

Manual Restraints Systems – 2003 Chevrolet Silverado

The 2003 Chevrolet Silverado was equipped with integrated manual 3-point lap and shoulder belts for the outboard seating positions. The front safety belts were integrated into the seats. The driver's safety belt was configured with a sliding latch plate and a belt-sensitive Emergency Locking Retractor (ELR). The driver and front right passenger utilized their safety belts. The front right and two rear outboard safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractor (ALR). The rear center safety belt was manual a 2-point lap belt that was configured with a locking latch plate.



Figure 8. Integrated driver's safety belt.

Certified Advanced 208-Compliant Safety System – 2003 Chevrolet Silverado

The manufacturer of this vehicle has certified that this 2003 Chevrolet Silverado meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The system included dual stage frontal air bags, seat track position sensor for the front left and front right seats and an occupant detection sensor for the front right seat. The system was monitored and controlled by a Sensing and Diagnostic control Module (SDM) that was located on the floor under the driver's seat. The SDM deploys the appropriate safety component(s) dependant on occupant presence, belt usage, seat track position and crash severity. In this crash, the SDM did not command deployments of the air bags due to the crash severity being minor.

Event Data Recorder (EDR) 2003 Chevrolet Silverado

The 2003 Chevrolet Silverado equipped with an Event Data Recorder (EDR). The NASS researcher successfully downloaded the EDR, which recorded a non-deployment event. The EDR data indicates that the driver's safety belt was buckled at the time of the crash. The EDR also data indicated the Chevrolet was traveling at 106.0 km/h (66.0 mph) five seconds prior to the crash and had slowed to 51.5 km/h (32.0 mph) one second prior to the crash. This output is included with this report as **Attachment A**.

Occupant Demographics – 2003 Chevrolet Silverado

Driver

Age/Sex: 33-year-old male
Height: 203.0 cm (80.0")
Weight: 125.0 kg (276.0 lbs)
Seat Track Position: Full Rear
Manual Restraint Use: Integrated manual 3-point lap and shoulder belt
Usage Source: Vehicle inspection
Eyewear: Eyeglasses/sunglasses
Type of Medical Treatment: Refused transport from scene. Sought treatment at a later time at a local hospital.

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Bilateral knee contusions	Minor (890402.1,3)	Knee bolster
Left foot contusion	Minor (890402.1,2)	Brake pedal

Injury source: Emergency room records, driver interview

Driver Kinematics

The 33-year-old male driver of the 2003 Chevrolet Silverado was seated in an upright driving posture and was restrained by the integrated manual 3-point lap and shoulder belt. The seat track was in the full rear position. At impact, the restrained driver initiated a forward trajectory and loaded the safety belt. His knee's contacted the knee bolster resulting in the bilateral knee contusions. The driver's left foot contacted the brake pedal resulting in the left foot contusion. The driver refused medical treatment at the scene. The driver went home after the crash and after some time, felt sore and transported himself to a local hospital for treatment. The driver was treated and released from the hospital.

Occupant Demographics – 2003 Chevrolet Silverado

Front Right Passenger

Age/Sex: 28-year-old male
Height: 180.0 cm (71.0")
Weight: 92.0 kg (203.0 lbs)
Seat Track Position: Full rear
Manual Restraint Use: Integrated manual 3-point lap and shoulder belt
Usage Source: Vehicle Inspection
Eyewear: No
Type of Medical Treatment: Refused transport from scene. Sought treatment at a later time at a local hospital.

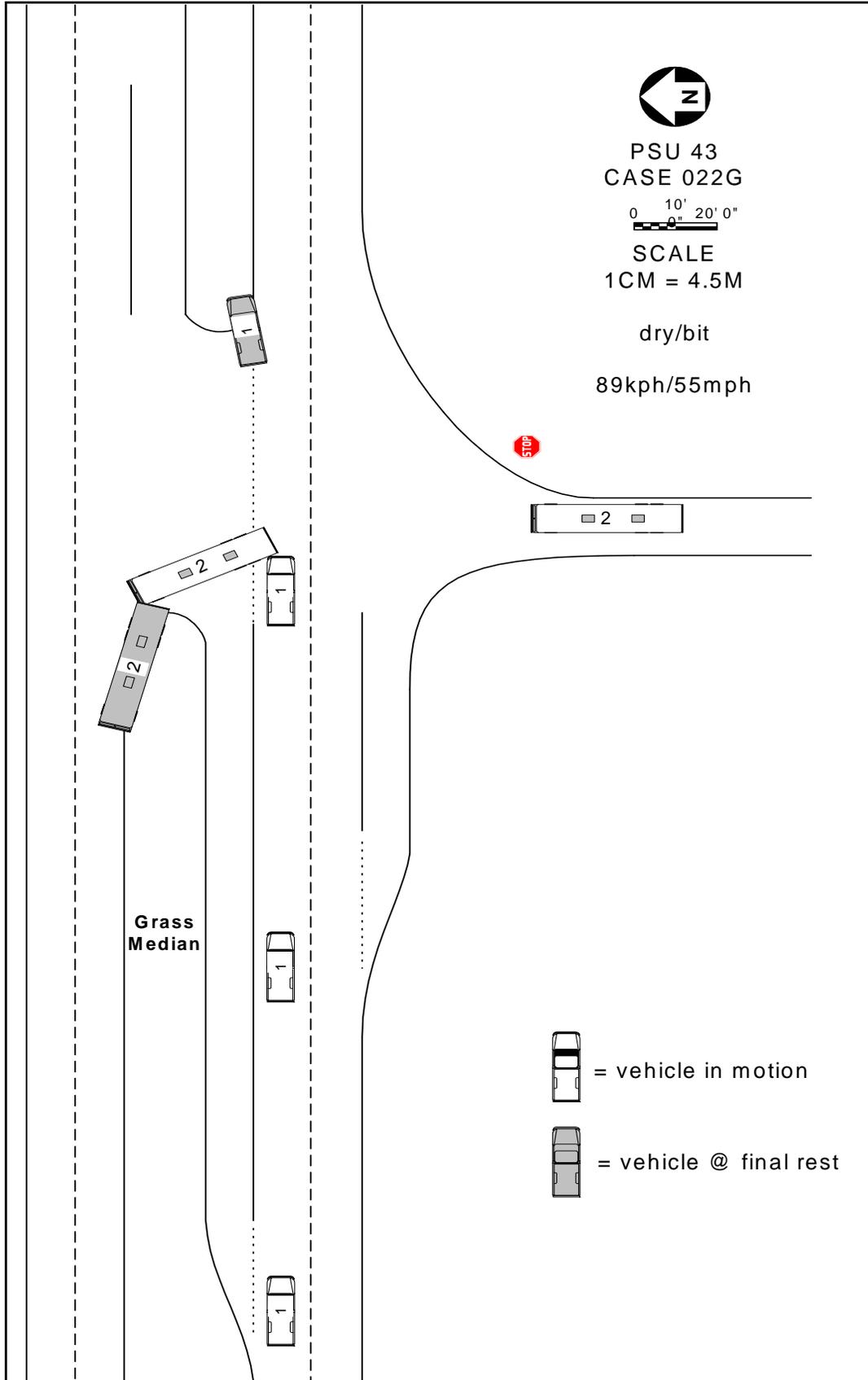
Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Cervical spine strain	Minor (640278.1,6)	Flexion
Right knee contusion	Minor (890402.1,1)	Glove box door

Front Right Passenger Kinematics

The 28-year-old male front right passenger was seated in a presumed upright posture and restrained by the integrated manual 3-point lap and shoulder belt. The seat track was in the full rear position. The front right passenger sustained police reported possible injuries however; he refused medical treatment at the scene. The restrained passenger initiated a forward trajectory and loaded the safety belt causing his head to flex over the belt, which resulted in the cervical spine strain. The passengers left knee contacted the glove box door, which resulted in the left knee contusion. The front right passenger went home after the crash and after about an hour he continued to have soreness in his neck and developed a headache. The passenger then went to the hospital and was diagnosed with a cervical spine strain and a bruised right knee. The front right passenger was treated for his injuries and released.

Figure 18. NASS Scene Schematic



Attachment A: EDR output



CDR File Information

Vehicle Identification Number	[REDACTED]
Investigator	[REDACTED]
Case Number	[REDACTED]
Investigation Date	[REDACTED]
Crash Date	[REDACTED]
Filename	[REDACTED]
Saved on	[REDACTED]
Data check information	[REDACTED]
Collected with CDR version	Crash Data Retrieval Tool 1.680
Collecting program verification number	[REDACTED]
Reported with CDR version	Crash Data Retrieval Tool 2.00
Reporting program verification number	[REDACTED]
Interface information	Block number: 00 Interface version: 34 [REDACTED]
Event(s) recovered	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). It contains Pre-Crash and Crash data. 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. This event will be cleared by the SDM after the ignition has been cycled 250 times.
The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. Deployment events can not 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 file will be locked after a deployment, if the non-deployment occurred within 5 seconds before the deployment or a deployment level event occurs within 5 seconds after the deployment.

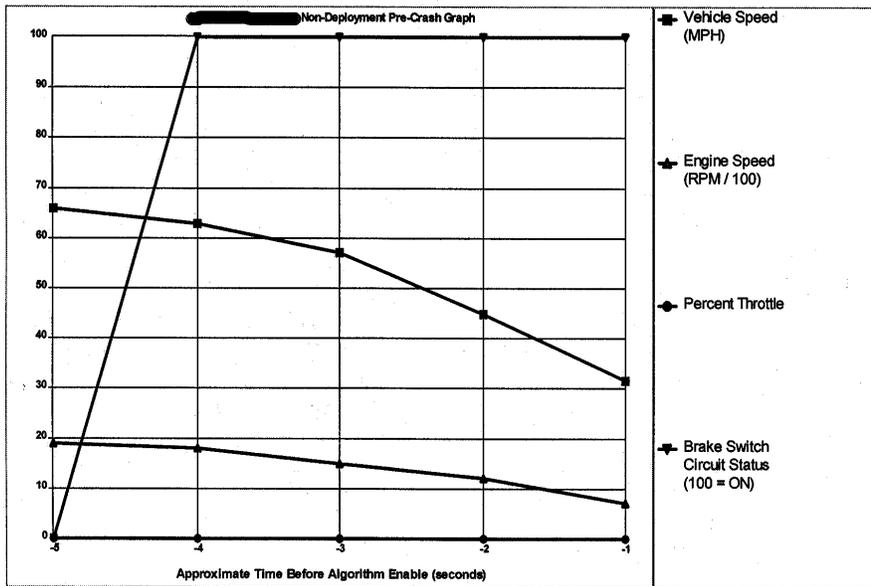
- SDM Data Limitations:
- SDM Recorded Vehicle Forward Velocity Change is one of the measures used to make air bag deployment decisions. SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. The SDM will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. The SDM will also record 150 milliseconds of data after non-deployment criteria is met.
 - 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 does not receive a valid message for any of the four Pre-Crash data parameters (Vehicle Speed, Engine Speed, Percent Throttle, and Brake Switch Circuit Status).
 - Driver's Belt Switch Circuit Status indicates the status of the driver's 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 25.4 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.

SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the Class 2 data link, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the Class 2 data link, to the SDM.
-In most vehicles, the Driver's Belt Switch Circuit is wired directly to the SDM. In some vehicles, the Driver's Belt Switch Circuit Status data is transmitted from the Body Control Module (BCM), via the Class 2 data link, to the SDM.

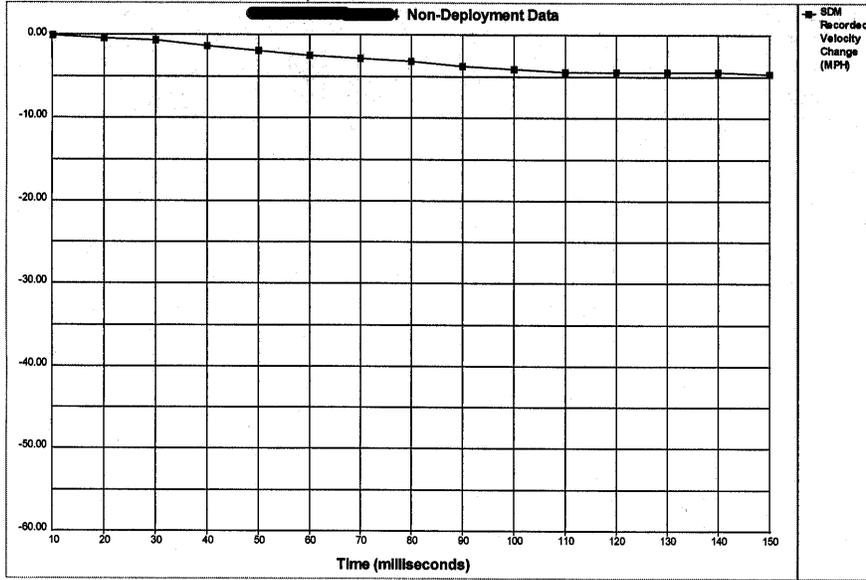
[REDACTED]

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	678
Ignition Cycles At Investigation	684
Maximum SDM Recorded Velocity Change (MPH)	-4.97
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	215
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	66	1856	0	OFF
-4	63	1792	0	ON
-3	57	1536	0	ON
-2	45	1152	0	ON
-1	32	704	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	-0.31	-0.62	-1.24	-1.86	-2.48	-2.79	-3.10	-3.72	-4.03	-4.34	-4.34	-4.34	-4.34	-4.65