TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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GENERAL DYNAMICS REMOTE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION

SCI TECHNICAL SUMMARY REPORT

NASS/SCI COMBO CASE NO. 03-43-273E

VEHICLE – 2003 CHEVROLET SUBURBAN

LOCATION - STATE OF NORTH CAROLINA

CRASH DATE – NOVEMBER 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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National Highway Traffic Safety Administration
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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.

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This remote investigation focused on the performance of the Certified Advanced 208-Compliant safety system in a 2003 Chevrolet Suburban.

16. Abstract

This remote investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system in a 2003 Chevrolet Suburban. The manufacturer of this vehicle has certified that this 2003 Chevrolet Suburban meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system consisted of dual stage frontal air bags, seat track position sensors for the front seats, safety belt buckle switch sensors, and an occupant presence sensor for the front right seat. In addition, the Chevrolet was equipped seatback mounted side impact air bags that did not deploy in this crash, and an Event Data Recorder (EDR) that was downloaded (Deployment and Deployment Level) by the NASS researcher and is included as **Attachment A** of this report. The Chevrolet was involved in a multiple event run-off-road crash with subsequent impacts to a 1996 Geo Tracker, and a 1999 Toyota Sienna. The Chevrolet was occupied by a restrained 48-year-old male driver. The 1996 Geo Tracker was occupied by a 35-year-old-female driver and a 14-year-old female front right occupant. The 1999 Toyota Sienna was occupied by a 53-year-old male driver and three adult passengers. The Chevrolet was traveling northbound on a five-lane north/south roadway approaching an intersection. The Chevrolet departed the east road edge and impacted two street signs, a utility pole, and five trees and then reentered the roadway. As the Chevrolet continued north the front left aspect sideswiped the right side of the 1996 Geo Tracker. The Chevrolet then began to travel in a northwest direction and entered the intersection. The Chevrolet entered the center southbound lane and the front of the Chevrolet impacted the front of the Toyota. The Chevrolet then continued in a northwest trajectory and the front wheels impacted a curb. The Chevrolet traveled off-road and impacted two guy wires with its front as it came to rest. As a result of the crash, the driver's frontal air bag deployed in the Chevrolet. The driver of the Chevrolet sustained an AIS-3 lumbar spine fracture, an AIS-3 radius fracture, fractures of the right ulna styloid and fibula lateral malleous. In addition, the driver sustained multiple soft tissue injuries. The driver was transported to a local trauma center where he was hospitalized for ten days and released. The Chevrolet and the Toyota sustained moderate damage and were towed from the crash site. The Geo sustained minor damage and was not towed from the crash site.

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NASS/SCI COMBO CASE NO. 03-43-273E
SUBJECT VEHICLE – 2003 CHEVROLET SUBURBAN
LOCATION - STATE OF NORTH CAROLINA
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BACKGROUND

This remote investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system **(Figure 1)** in a 2003 Chevrolet Suburban. The manufacturer of this vehicle has certified that this 2003 Chevrolet Suburban meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The safety system consisted of dual stage frontal air bags, seat track position sensors for the front seats, safety belt buckle switch sensors, and an occupant presence sensor for the front right seat. In addition, the Chevrolet was equipped seatback mounted side impact air bags that did not deploy in this crash, and an Event Data Recorder (EDR) that was downloaded (Deployment and Deployment Level) by the NASS researcher and is included as **Attachment A** of this report. The Chevrolet was involved in a multiple event run-off-road crash with subsequent impacts to a 1996 Geo Tracker, and a 1999 Toyota Sienna. The Chevrolet was occupied by a restrained 48-year-old male driver. The 1996 Geo Tracker was occupied by a 35-year-old-female driver and a 14-year-old female front right occupant. The 1999 Toyota Sienna was occupied by a 53-year-old male driver and three adult passengers. The Chevrolet was traveling northbound on a five-lane north/south roadway approaching an intersection. The Chevrolet departed the east road edge and impacted two street signs, a utility pole, and five trees and then reentered the roadway. As the Chevrolet continued north the front left aspect sideswiped the right side of the 1996 Geo Tracker. The Chevrolet then began to travel in a northwest direction and entered the intersection. The Chevrolet entered the center southbound lane and the front of the Chevrolet impacted the front of the Toyota. The Chevrolet then continued in a northwest trajectory and the front wheels impacted a curb. The Chevrolet traveled off-road and impacted two guy wires with its front as it came to rest. As a result of the crash, the driver's frontal air bag deployed in the Chevrolet. The driver of the Chevrolet sustained an AIS-3 lumbar spine fracture, an AIS-3 radius fracture, fractures of the right ulna styloid and fibula lateral malleous. In addition, the driver sustained multiple soft tissue injuries. The driver was transported to a local trauma center where he was hospitalized for ten days and released. The Chevrolet and the Toyota sustained moderate damage and were towed from the crash site. The Geo sustained minor damage and was not towed from the crash site.

Figure 1. Subject 2003 Chevrolet Suburban.

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. 03-43-273E. The NASS PSU performed the vehicle and scene inspections. Due to the presence of the Certified Advanced 208-Compliant safety system in the 2003 Chevrolet Suburban, NHTSA assigned the tasks of case review and report preparation to the General Dynamics SCI team.

SUMMARY

Crash Site

This multiple event crash occurred during the morning hours of November 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 events occurred off-road prior to an intersection and at a four-leg intersection of two local roads. The north/southbound roadway consisted of five northbound travel lanes and two southbound travel lanes. The north/southbound roadway was separated by a raised concrete median and was bordered by mountable concrete curbs and had an uphill grade for the northbound travel. The east/west roadsides consisted of grass, street signs, utility poles, guy wires, and trees. The east/westbound roadway was a six-lane, two-way roadway that was delineated by a double yellow centerline. The posted speed limit for the north/southbound roadway was 72 km/h (45 mph).

Vehicle Data

2003 Chevrolet Suburban

The 2003 Chevrolet Suburban was identified by the Vehicle Identification Number (VIN): 1GNFK16Z93 (production sequence omitted). The odometer reading was 25,695 kilometers (15,966 miles) at the time of the NASS inspection. The vehicle was a large four-door sport utility vehicle that was equipped with a 5.3-liter, eight-cylinder engine linked to a four speed automatic transmission, four-wheel drive, four-wheel disc brakes with ABS, and daytime running lights. The tires on the Chevrolet were Michelin LTX M/S, size P265/70R16. The manufacturer recommended front and rear tire pressure was 241 kpa (35 psi). The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kpa	8 mm (10/32)	No	Punctured sidewall
LR	207 kpa (30 psi)	9 mm (11/32)	No	None
RF	0 kpa	8 mm (10/32)	Yes	Punctured sidewall
RR	207 kpa (30 psi)	9 mm (11/32)	No	None

The Chevrolet was configured with front bucket seats with height adjustable head restraints that were adjusted to the full-down position at the time of the NASS inspection. The second and third rows were configured with three-passenger split bench seats with height adjustable head restraints for the outboard positions. The rear head restraints were adjusted to the full-down position except for the second row right that was adjusted to the

full-up position and at the time of the inspection. The Chevrolet was also equipped with power adjustable pedals that were adjusted to the full-forward position at the time of the NASS inspection.

1999 Toyota Sienna

The 1999 Toyota Sienna was identified by the VIN: 4T3ZF13CXX (production sequence omitted). The odometer reading was unknown at the time of the inspection due to the vehicle having no power. The driver stated to the NASS researcher that the vehicle had approximately 114,000 kilometers (71,000 miles) at the time of the crash. The vehicle was a four-door mini van that was equipped with a 3.0-liter, six-cylinder engine, four-speed automatic transmission, front-wheel drive, four-wheel ABS, and daytime running lights. The tires on the Toyota were Dunlop SP40 A/S, size P205/70R15. The manufacturer recommended tire pressure was 241 kpa (35 psi). The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	221 kpa (32 psi)	6 mm (8/32)	No	None
LR	228 kpa (33 psi)	6 mm (8/32)	No	None
RF	221 kpa (32 psi)	6 mm (8/32)	No	None
RR	221 kpa (32 psi)	2 mm (3/32)	No	None

The Toyota was configured with two front box mounted van seats with height adjustable head restraints that were adjusted between the mid to full-up position at the time of the NASS inspection. The second row was configured with two-captain seats with height adjustable head restraints that were adjusted to the full-down position at the time of the NASS inspection. The third row was configured with a three-passenger bench seat with height adjustable head restraints for the outboard seats. The right head restraint was adjusted between the mid to full-up position and the left head restraint was adjusted to the full-down position at the time of the NASS inspection. The NASS coding of the front and second row seat types were buckets. This was revised to reflect the correct seat types for this report.

1996 Geo Tracker

The 1996 Geo Tracker was identified by the VIN: 2CNBJ1368T (production sequence omitted). The odometer reading was unknown at the time of the inspection. The vehicle was a compact four-door sport utility vehicle that was equipped with a 1.6-liter, four-cylinder engine, four-speed automatic transmission, and four-wheel drive. The left front, right front, and right rear tires were Douglas Xtra-Trac A/W, size P205/70R15. The left rear tire was a Radial Steel Belted Traction XTC, size P235/75R15. The specific tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	97 kpa (14 psi)	3 mm (4/32)	No	None
LR	214 kpa (31 psi)	7 mm (9/32)	No	None
RF	110 kpa (16 psi)	3 mm (4/32)	No	None
RR	103 kpa (15 psi)	3 mm (4/32)	No	None

The interior inspection of the Geo was not required due to NASS protocols since this vehicle was driven from the crash site. Therefore, the exact seat and safety belt types were unknown.

Crash Sequence

Pre-Crash

The restrained 48-year-old male driver of the Chevrolet was operating the vehicle northbound approaching the intersection **(Figure 2)**. The 35-year-old-female driver of the Geo was operating the vehicle northbound in the right lane on the same road approaching the intersection where she was slowing the vehicle for the red traffic signal. The 53-year-old male driver of the Toyota was operating the vehicle southbound in the center lane approaching the intersection where the driver was slowing for the red traffic signal. As the Chevrolet continued northbound, the vehicle departed the east road edge and began to travel off-road. The NASS scene schematic is included as **Figure 21** of this report.

Figure 2. Chevrolet's northbound approach.

Crash

The Chevrolet traveled approximately 11.0 meters (36.0 feet) off-road and impacted a signpost with its front **(Figure 3)**. The signpost subsequently sheared and impacted the right side of the roof. The Chevrolet continued an additional 60.0 meters (197.0 feet) and impacted a wooden utility pole with its front **(Figure 4)** which resulted in the Stage One deployment of the driver's frontal air bag at 10 milliseconds Algorithm Enable (AE). The EDR data indicated that the vehicle speed was 19.3 km/h (12.0 mph) five seconds prior to AE and the vehicle's speed increased to 64.3 km/h (40.0 mph) one second prior to AE. The EDR data also indicated that the brake switch status

Figure 3. Event 1, struck signpost.

was in the off-position from five seconds to one second prior to AE and the maximum recorded delta V was 6.1 km/h (-3.8 mph) at 42.5 milliseconds. The struck utility pole was replaced, however, it's unknown if the replacement utility pole was positioned in the same location of the struck utility pole. Based on the location of the replacement utility pole, the damage should have been located on the frontal plane inboard of the left front wheel. No utility pole related damage was evident on the vehicle at this location. Given the low delta V recorded by the EDR, it appears the Chevrolet may have glanced the utility pole causing sufficient damage to warrant a replacement and not knocked down as reported by the police. The Chevrolet continued in its northbound direction approximately 14.0 meters (46.0 feet) and impacted four small trees that ranged in diameter from 3.0-5.0 cm (1.0-2.0") with its frontal plane **(Figure 5)**. The Chevrolet began to travel in a northwest direction following the impacts to the trees and traveled an additional 6.0 meters (20.0 feet) and impacted a 13.0 cm (5.1") diameter tree with its right rear quarter panel and a signpost that was located 2.0 meters (7.0 feet) north of the tree with its right rear quarter panel **(Figure 6)**. The NASS researcher documented approximately 93.0 meters (305.0 feet) of off-road rotating tire marks from the Chevrolet that were consistent with vehicle traveling in a tracking mode. The vehicle sustained unknown severity frontal damage for the multiple off-road impacts and minor damage from the right side impacts. Due to the multiple overlapping frontal impacts to the Chevrolet the WINSMASH program was not used to calculate a delta V.

Figure 4. Event 3, with a utility pole, replaced.

Figure 5. Events 4-7 with small diameter trees.

Figure 6. Events 8 and 9 to tree and signpost.

Upon impact with the signpost, the Chevrolet re-entered the northbound roadway and began to travel in a northerly direction in the right lane. The Chevrolet traveled in the right lane approximately 26.0 meters (85.0 feet) where the left front of the Chevrolet impacted the right rear of the Geo in a sideswipe impact configuration **(Figure 7)**. The resultant directions of force were within the 12 o'clock sector the Chevrolet and the 6 o'clock sector for the Geo. The WINSMASH program was not used to determine a delta V for this impact due to the sideswipe damage pattern.

Figure 7. Area of impact between the Chevrolet and the Geo.

Subsequent to the impact with the Geo, the Chevrolet traveled in northwest direction for approximately 110.0 meters (361.0 feet) through the intersection toward the southbound travel lanes. The EDR recorded a deployment level event 11.0 seconds following the deployment event. The EDR deployment level data indicated that the Chevrolet's travel speed was 65.9 km/h (41.0 mph) five seconds prior to AE and the speed increased to 85.3 km/h (53.0 mph) one second prior to AE. The Chevrolet entered the center southbound lane where the Toyota was approaching the intersection slowing for the red traffic signal. The frontal aspect of the Chevrolet **(Figure 8)** impacted the frontal aspect of the Toyota. The resultant directions of force were within the 12 o'clock sector for both vehicles. The WINSMASH barrier equivalent algorithm was used to determine an approximate delta V for this impact due to the multiple impacts to the frontal plane of the Chevrolet. The calculated barrier equivalent speed for the Chevrolet was 34.0 km/h (21.2 mph) and 39.0 km/h (24.2 mph) for the Toyota. The EDR deployment level data indicated that the maximum-recorded delta V was -36.5 km/h (-22.7 mph) and the first stage deployment of the driver's frontal air bag was commanded at 12.5 milliseconds and the second stage was commanded at 20.0 milliseconds.

Figure 8. Area of impact between the Chevrolet and the Toyota.

The Toyota was deflected rearward rotating clockwise and came to rest approximately 40.0 meters (131.0 feet) north of the point of impact facing southeast. The Chevrolet continued its northwest direction and departed the west road edge and impacted a curb with its left front wheel **(Figure 9)**. The Chevrolet then impacted two guy wires **(Figure 10)** with its frontal plane and came to rest against the guy wires facing northwest.

Figure 9. Chevrolet's curb impact on approach to rest.

Figure 10. Chevrolet's impact to guy wires and final rest.

Post-Crash

The driver of the Chevrolet sustained an AIS-3 lumbar spine fracture, an AIS-3 radius fracture, and fractures of the right ulna styloid and fibula lateral malleous. In addition, the driver sustained multiple soft tissue injuries. The driver was transported toa trauma center where he was treated for his injuries. He released after 10 days of hospitalization. The Chevrolet and the Toyota sustained severe damage and were towed from the crash site. The Geo sustained minor damage and was not towed from the crash site.

Vehicle Damage

Exterior – 2003 Chevrolet Suburban

The 2003 Chevrolet Suburban sustained moderate damage as a result of the multiple event crash. Several of the damage assessments were derived from the vehicle inspection images due to the overlapping impacts to the frontal plane.

The 2003 Chevrolet Suburban sustained minor damage as a result of the initial impact to the signpost. Although it was not documented by the NASS researcher, the direct damage was located approximately 10.0 cm (4.0") left of the centerline **(Figure 11)**. The maximum crush was approximately 2.5 cm (1.0") on the face of the hood. A crush profile was not documented for this impact due to the overlapping impacts to the frontal plane.

Figure 11. The damage from the signpost is located left of center.

Figure 12. Roof damage from the signpost is located left of the right A-pillar.

The second event involved the initial signpost that was sheared and contacted the right side of the windshield header and upper windshield **(Figure 12)**. The direct damage appeared to be approximately 5.0 cm (2.0") in width and began left of the right A-pillar.

The third event was the front of the Chevrolet impacting a utility pole. The exact area of contact could not be located on the vehicle. Based on the crash site images, it appears that the off-road rotating tire marks indicated that the replacement utility pole was positioned inboard of the left wheel. This was not consistent with the damage to the vehicle which did not support and impact to the front left aspect. The struck pole may not have been located in the position of the replacement.

The fourth event involved the front of the Chevrolet impacting a 3.0 cm (1.2") diameter tree. The direct damage could not be identified from this impact due to the overlapping impacts.

The fifth event involved the front of the Chevrolet impacting a 4.0 cm (1.6") diameter tree. The direct damage from this impact was unknown due to the multiple overlapping impacts.

The sixth event involved the front of the Chevrolet impacting a subsequent 4.0 cm (1.6") diameter tree. The direct damage could not be identified from this impact due to the multiple overlapping impacts.

The seventh event involved the front of the Chevrolet impacting a 5.0 cm (1.9") tree. The direct damage was masked from this impact due to the overlapping impacts.

The eighth event consisted of the right rear side of the Chevrolet impacting a 13.0 cm (5.1") diameter tree **(Figure 13)**. The direct damage measured 62.0 cm (24.4") and began on the right rear bumper corner and extended forward. The damage involved the right rear quarter panel, right rear taillight, and the rear bumper. Six crush measurements were documented along the mid-door level using a combined direct and induced damage width of 177.0 cm (69.7") and were as follows: C1= 3.0 cm (1.2"), C2= 2.0 cm (0.8"), C3= 0, C4= 0, C5= 0, C6= 0.

Figure 13. Area of damage from tree and signpost.

The ninth event consisted of the right rear side of the Chevrolet impacting a signpost **(Figure 13)**. The NASS researcher did not measure the residual damage for this event. Therefore, the direct damage was estimated for this report by the SCI investigator. The direct measured approximately 12.7 cm (5.0") and was located approximately 52.0 cm (21.0") forward of the right rear bumper corner. A crush profile was not obtained for this impact.

The tenth event was the left front aspect of the Chevrolet sideswiping the right side of the Geo **(Figure 14)**. The direct damage width measured 101.0 cm (39.8") and began on the front left bumper corner and extended rearward. The direct damage consisted black longitudinal abrasions on the left side of the front bumper from contact with Geo's right rear tire and lateral deformation of the left front fender. Six crush measurements were documented along the mid-door level using a combined direct and induced damage width of 179.0 cm (70.5"), and were as follows: C1= 0, C2= 0, C3= 0, C4= 1.0 cm (0.4"), C5= 3.0 cm (1.2"), C6= 2.0 cm (0.8").

Figure 14. Area of damage from impact with the Geo.

The eleventh event involved the frontal aspect of the Chevrolet **(Figure 15)** impacting the frontal aspect of the Toyota. The direct damage measured 111.0 cm (43.7") and began 50.0 cm (19.7") right of the front left bumper corner and extended right. The maximum crush was located 82.0 cm (32.3") right of the front left bumper corner and measured 63.0 cm (24.8"). The damage consisted of longitudinal deformation of the front bumper, hood, radiator, and the right frame rail. As a result of the impact the right side wheelbase was reduced 26.0 cm (10.2") and left side wheelbase was increased 5.0 cm (1.9"). Six crush measurements were documented along the front bumper using a combined direct and induced damage width of 161.0 cm (63.3") and were as follows: C1= 1.0 cm (0.4), C2= 11.0 cm (4.3"), C3= 25.0 cm (9.8"), C4= 41.0 cm (16.1"), C5= 41.0 cm (16.1"), C6= 54.0 cm (21.3").

Figure 15. Damage from impact with the Toyota.

The twelfth event involved the front wheels impacting a curb. The direct damage consisted of the sidewall being punctured and deformation of the front alloy rims.

The thirteenth event involved the front impacting a guy wire **(Figure 16)**. The direct damage was located approximately 25.0 cm (10.0") right of the centerline and consisted of vertical abrasions and longitudinal deformation of the hood edge.

Figure 16. Damage from guy wire impacts is right of the center.

The fourteenth event involved the front right hood edge impacting a guy wire **(Figure 16)**. The direct damage consisted of longitudinal deformation and vertical abrasions to the front right hood edge.

The Collision Deformation Classifications (CDC) for this multiple event crash are identified in the following **Table 1**.

Table 1. Collision Deformation Classifications

Event No.	CDC	Object Struck
1	12-FZGN-1	Signpost
2	00-TPRN-2	Signpost
3	12-F999-9	Utility Pole
4	12-F999-9	3.0 cm (1.2”) Tree
5	12-F999-9	4.0 cm (1.6”) Tree
6	12-F999-9	4.0 cm (1.6”) Tree
7	12-F999-9	5.0 cm (1.9”) Tree
8	12-RBES-1	13.0 cm (5.1”) Tree
9	12-RBES-1	Signpost
10	12-LFES-1	Geo
11	12-FDEW-3	Toyota
12	SCI revised CDC 12-FDWW-3	Curb
13	12-FREN-1	Guy Wire
14	12-FREN-1	Guy Wire

Interior – 2003 Chevrolet Suburban

The 2003 Chevrolet Suburban sustained minor interior damage **(Figure 17)** as a result of occupant contacts. There were no intrusions into the passenger compartment. The NASS researcher documented a probable contact from the driver’s face to the frontal air bag. Body fluid was noted to multiple aspects of the air bag. A scuffmark from the driver’s left knee was noted to the knee bolster and a scuffmark to the inboard aspect of the center instrument panel/console from the driver’s right knee. The shoulder belt portion of the safety belt contained a red clothing transfer from the driver’s left shoulder loading the belt. Also noted was stretching to the lap belt portion of the safety belt from the driver’s abdomen loading the belt.

Figure 17. Overall view of driver's position.

Exterior – 1999 Toyota Sienna

The 1999 Toyota Sienna sustained moderate frontal damage as a result of the frontal impact with the Chevrolet **(Figure 18)**. The direct damage width was 109.0 cm (42.9") and began on the front left bumper corner and extended the full width of the bumper. The damage involved the bumper support, upper and lower radiator supports, front right fender, and the hood. Two crush profiles were documented at the level of the bumper and upper radiator support using a combined direct and induced damage width of 118.0 cm (46.9"). The average both crush profiles and was as follows: C1= 6.0 cm (2.4"), C2= 37.0 cm (14.6"), C3= 39.0 cm (15.4"), C4= 39.0 cm (15.4"), C5= 40.0 cm (15.7"), C6= 32.0 cm (12.6"). The CDC for this impact was 12-FDEW-3.

Figure 18. Damage sustained from frontal impact with the Chevrolet.

Exterior – 1996 Geo Tracker

The 1996 Geo Tracker sustained minor right side damage **(Figure 19)** as a result of the sideswipe impact with the Chevrolet. The direct damage width was 378.0 cm (148.8") and began 70.0 cm (27.5") rear of the right rear axle and extended forward. The maximum crush measured 2.0 cm (0.8") and was located at the end of the right rear quarter panel. The damage involved the entire right side of the vehicle and it consisted of lateral deformation and longitudinal abrasions. Six crush measurements were documented along the mid-door level using a combined direct and induced damage width of 378.0 cm (148.8"), and were as follows: C1= 2.0 cm (0.8"), C2= 1.0 cm (0.4"), C3= 0, C4= 0, C5= 0, C6= 0. The CDC for this impact was 06-RDES-1.

Figure 19. Sideswipe damage from impact with the Chevrolet.

Certified Advanced 208-Compliant Safety System – 2003 Chevrolet Suburban

The 2003 Chevrolet Suburban was equipped with a Certified Advanced 208-Compliant safety system. The manufacturer of this vehicle has certified that this 2003 Chevrolet Suburban 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 sensors for the front seats, safety belt buckle switch sensors, and an occupant presence sensor for

Figure 20. Deployed driver's frontal air bag. Note body fluid is a result of driver bleeding on the air bag and not from contact.

the front right seat. The system is monitored and controlled by a Sensing and Diagnostic Module (SDM). The SDM deploys the appropriate safety system dependant on crash severity, occupant presence, and seat track position. The third event of the crash involved the front of the Chevrolet impacting a utility pole. The system commanded a stage one deployment of the driver's frontal air bag at 42.5 milliseconds from AE. The air bag was located in the center of the steering wheel hub and was concealed by two symmetrical I-configuration cover flaps that measured 12.0 cm (4.7") in height and 7.0 cm (2.8") in width. The air bag membrane measured 68.0 cm (26.7") in diameter in its deflated state and contained two tethers. Two vent ports on the rear aspect of the air bag at the 11 and 1 o'clock positions vented the air bag. The NASS researcher documented the air bag as a probable contact point that was evidenced by body fluid on the air bag membrane.

No occupant was present in the front right, therefore the front right air bag did not deploy in this crash.

Event Data Recorder – 2003 Chevrolet Suburban

The 2003 Chevrolet was equipped with an Event Data Recorder (EDR) that was downloaded (Deployment and Deployment Level) by the NASS researcher. The EDR printout is included as **Attachment A** of this report. The EDR recorded a deployment file first, which was a result of the utility pole impact. The EDR indicated that the driver's safety belt was buckled at the time of crash. The EDR shows that the vehicle speed was 19.3 km/h (12.0 mph) five seconds prior to AE and that the speed increased to 64.3 km/h (40.0 mph) one second prior to AE. The EDR data also indicated that the brake switch status was in the off-position from five seconds to one second prior to AE and the maximum-recorded delta V was 6.1 km/h (-3.8 mph) at 42.5 milliseconds from AE.

The EDR also recorded a Deployment Level event that was a result of the impact with Toyota. The deployment level shows that the vehicle speed was 65.9 km/h (41.0 mph) five seconds prior to AE and the vehicle speed increased to 85.2 km/h (53.0 mph) one second prior to AE. The data also indicates that the driver's safety belt was buckled and the brake switch status was in the off-position from five seconds to one second prior to AE. Although the driver's frontal air bag deployed during the impact with the utility pole, the deployment level data shows a dual stage deployment of the driver's frontal air bag. The stage one deployment of the driver's frontal air bag was commanded at 12.5 milliseconds from AE and the second stage was commanded at 20.0 milliseconds form AE. The maximum-recorded delta V for this impact was -36.5 km/h (-22.7mph).

Manual Restraint Systems – 2003 Chevrolet Suburban

The 2003 Chevrolet Suburban was equipped with integrated manual 3-point lap and shoulder safety belts for the front seating positions. The second row was configured with manual 3-point lap belt and shoulder belts. The third row outboard seating positions were configured with integrated manual 3-point lap and shoulder belts. The third row center seating position was configured with a manual 2-point lap belt. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor

(ELR). The driver utilized the safety belt in this crash, which was evidenced by a red clothing transfer on the shoulder belt portion and stretching of the lap belt portion from occupant loading. The front right, second row, and rear outboard safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractor's (ALR). The third row center safety belt was configured with a locking latch plate and no retractor.

Side Impact Air Bags – 2003 Chevrolet Suburban

The 2003 Chevrolet Suburban was equipped with seatback mounted side impact air bags for the front seating positions. In this crash, the side impact air bags did not deploy.

Occupant Demographics – 2003 Chevrolet Suburban

Driver

Age/Sex:	48-year-old male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Full rear
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a local trauma center where he was hospitalized for ten days

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Lumbar fracture of the vertebral body with major compression of L4 (50% spinal canal narrowing)	Serious (650634.3,8)	Impact forces
Right distal radius and radial styloid fracture, displaced ventrally	Serious (752804.3,1)	Center instrument panel
Right closed ulna styloid fracture	Moderate (753202.2,1)	Center instrument panel
Right fibula fracture of the lateral malleous	Moderate (851608.2,2)	Toe pan
Right ankle contusion	Minor (890402.1, 1	Toe pan
22.9 cm (9.0") right anterior/front/ventral scalp superficial avulsion involving the forehead	Minor (290802.1,7); Minor (190802.1,5)	Steering wheel

Source- Post emergency room records

Driver Kinematics

The 48-year-old male driver of the 2003 Chevrolet Suburban was seated in a presumed upright driving posture and was restrained by the manual 3-point lap and shoulder belt. The seat track was adjusted to the full-rear position. The Chevrolet departed the east roadside and impacted and sheared a signpost with its front. The sheared signpost then struck the right side of the roof. These impacts were minor and did not displace the driver. As the Chevrolet continued off-road, the front of the vehicle impacted the wooden utility pole. Based on the EDR data, a stage one deployment of the driver's frontal air bag was commanded and the maximum-recorded delta V was 6.1 km/h (-3.8 mph), which was minor and probably did not result in the displacement of the driver. The Chevrolet also impacted four small diameter trees with its front and a tree and signpost with its right side. These impacts were minor and did not displace the driver. As the Chevrolet reentered the roadway it traveled northbound and the left front of the Chevrolet impacted the right side of the Geo in a sideswipe impact configuration. This impact was minor and did not result in the displacement of the driver. The Chevrolet then traveled across the intersection and the front of the Chevrolet impacted the front of the Toyota in a 12 o'clock impact configuration. The driver began a forward trajectory as result of the impact with the Toyota. At this point, the air bag had deflated and offered no protection to the driver thus allowing his forehead to contact the steering wheel which resulted in the 22.9 cm (9.0") right anterior/front/ventral scalp superficial avulsion involving the forehead. The driver's forward movement also resulted in the lumbar fracture with major vertebral body compression of L4 (50% spinal canal narrowing). The driver's lower right arm contacted the center instrument panel, which resulted in the right distal radius and radial styloid fracture displaced ventrally, and the right closed ulna styloid fracture. The driver's right foot loaded the toe pan which resulted in the right ankle contusion. The loading forces translated through the driver's leg and resulted in the right fibula fracture lateral malleous.

Medical Treatment

The driver was transported to a local trauma center where he was admitted for treatment. The driver was hospitalized for ten days as a result of his injuries.

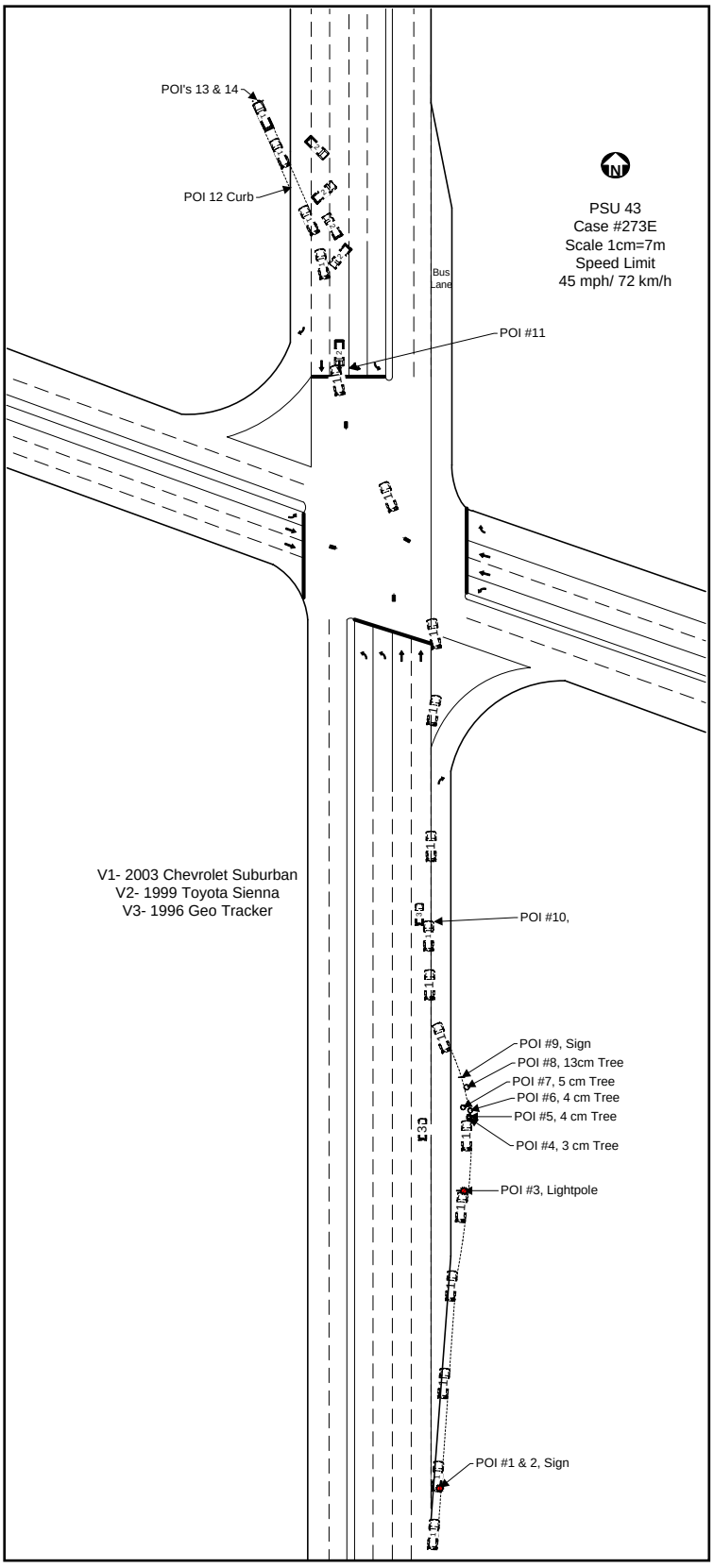

Figure 21. NASS Scene Schematic

Attachment A: EDR Printout

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CDR CRASH DATA RETRIEVAL SYSTEM

CDR File Information

Vehicle Identification Number	1GNFK16[redacted]
Investigator	[redacted]
Case Number	[redacted]
Investigation Date	[redacted]
Crash Date	[redacted]
Filename	1GNFK1[redacted]
Saved on	[redacted]
Data check information	[redacted]
Collected with CDR version	Crash Data Retrieval Tool 2.21
Collecting program verification numbe	[redacted]
Reported with CDR version	Crash Data Retrieval Tool 2.21
Reporting program verification numbe	[redacted]
Interface used to collected data	[redacted]
Event(s) recovered	Deployment Deployment Level

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. 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 deployments and deployment level events, the SDM will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. For non-deployments, the SDM will record the first 150 milliseconds of data after algorithm enable.
-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.
-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]

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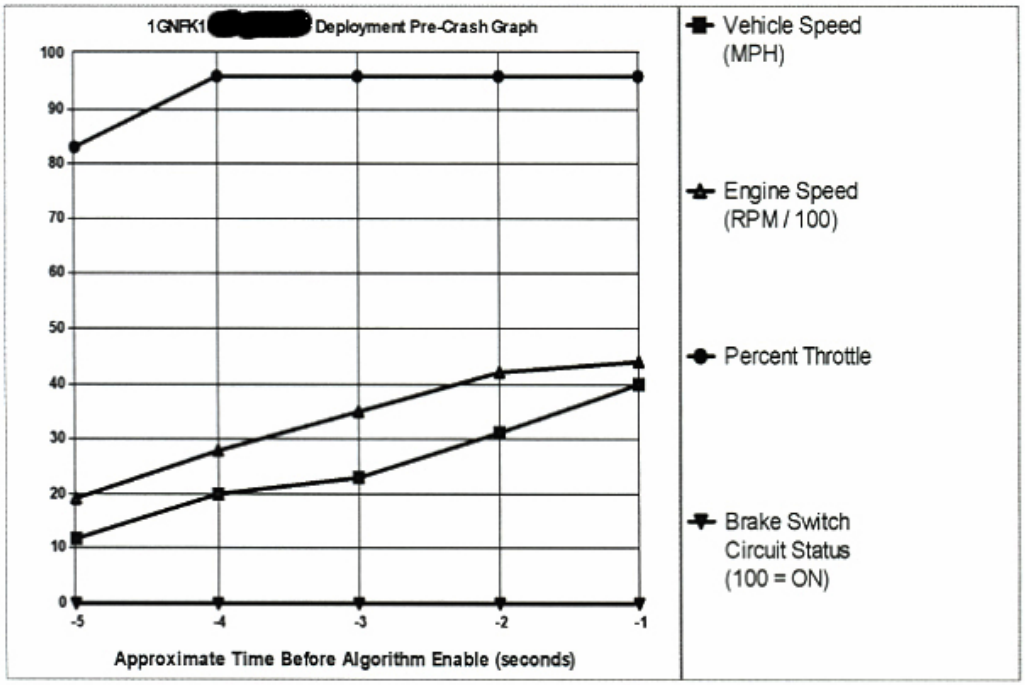
CDR CRASH DATA RETRIEVAL SYSTEM

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	1866
Ignition Cycles At Investigation	1868
Maximum SDM Recorded Velocity Change (MPH)	-3.88
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	42.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	10
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Time Between Non-Deployment And Deployment Events (sec)	N/A
Frontal Deployment Level Event Counter	2
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	12	1856	83	OFF
-4	20	2816	96	OFF
-3	23	3520	96	OFF
-2	31	4160	96	OFF
-1	40	4352	96	OFF

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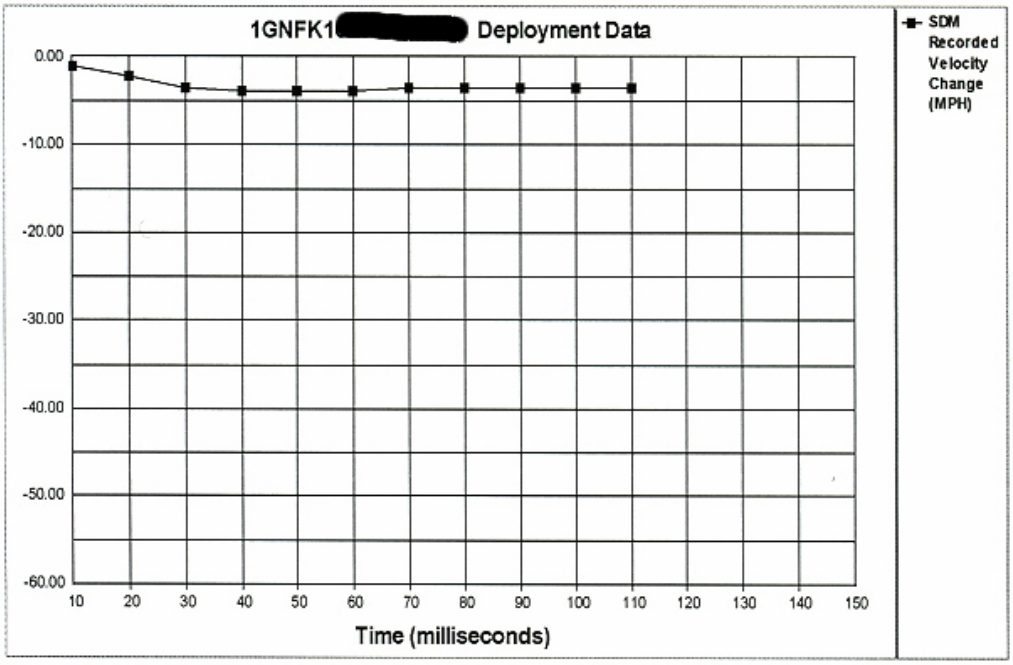
CDR CRASH DATA RETRIEVAL SYSTEM



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.93	-2.17	-3.41	-3.72	-3.72	-3.72	-3.41	-3.41	-3.41	-3.41	-3.41	N/A	N/A	N/A	N/A

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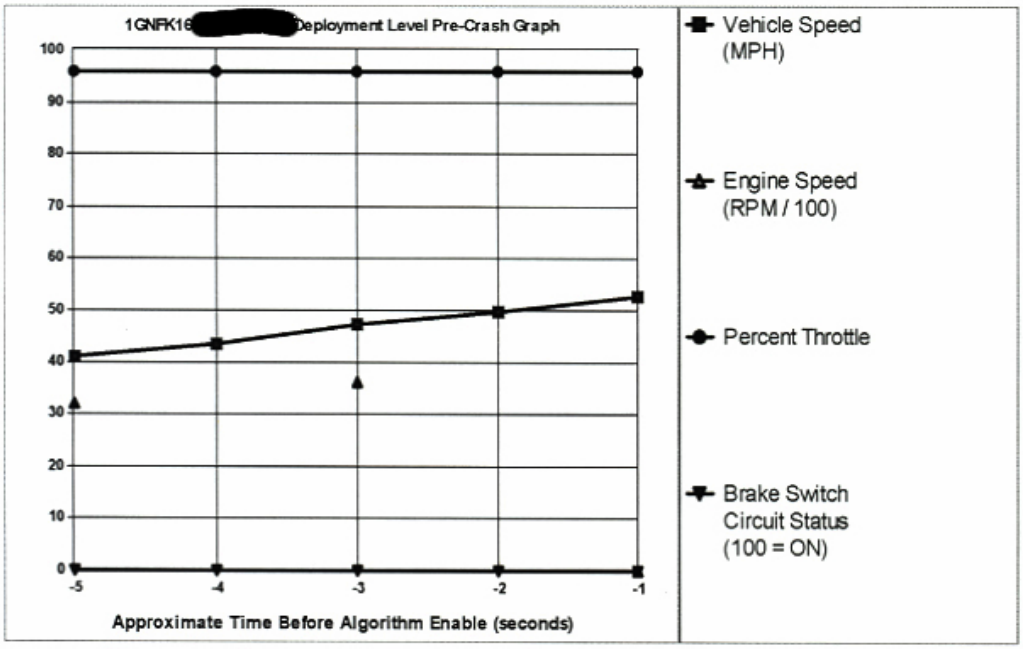
CDR CRASH DATA RETRIEVAL SYSTEM

System Status At Deployment Level

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment Level	1866
Ignition Cycles At Investigation	1868
Maximum SDM Recorded Velocity Change (MPH)	-22.72
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	135
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	20
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Frontal Deployment Level Event Counter	2
Time Between Deployment And Deployment Level Events (sec)	11
Event Recording Complete	Yes
Multiple Events Associated With This Record	Yes
One Or More Associated Events Not Recorded	Yes



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	41	3200	96	OFF
-4	44	Invalid	96	OFF
-3	47	3584	96	OFF
-2	50	Invalid	96	OFF
-1	53	0	96	OFF

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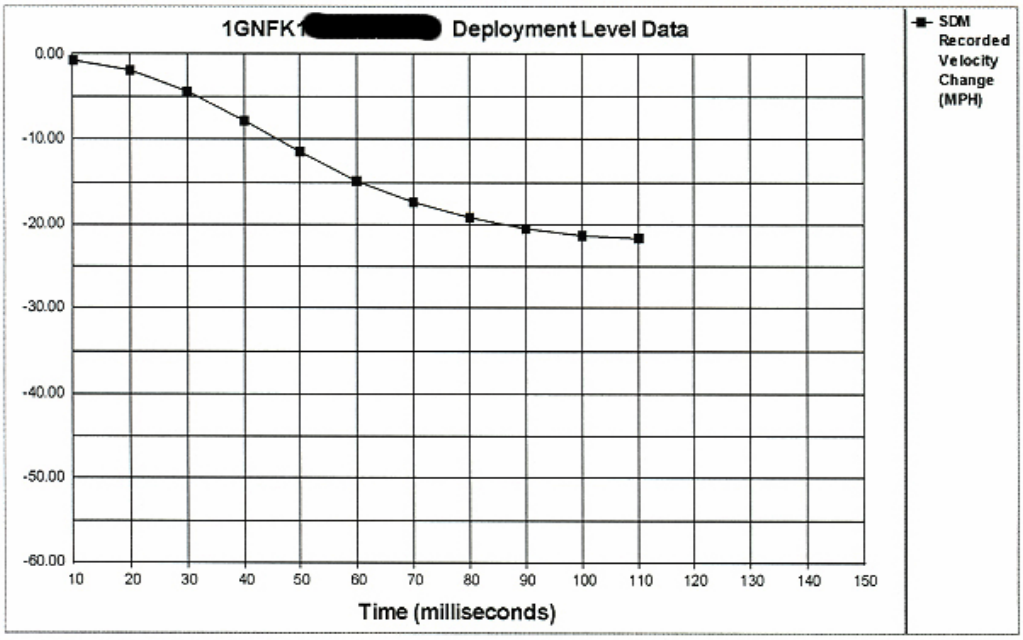
CDR CRASH DATA RETRIEVAL SYSTEM



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.62	-1.86	-4.34	-7.75	-11.47	-14.88	-17.36	-19.22	-20.46	-21.39	-21.70	N/A	N/A	N/A	N/A

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CDR CRASH DATA RETRIEVAL SYSTEMS

Hexadecimal Data

This page displays all the data retrieved from the air bag module.
It contains data that is not converted by this program.

$01	F1	26	C4	F8	AE	4A
$02	F1	F1	00	00	A8	00
$03	41	53	33	30	33	34
$04	4B	34	36	44	53	31
$05	30	41	57	5A	39	32
$06	15	19	24	48	00	00
$07	30	03	31	56	00	00
$08	41	44	75	06	56	30
$09	28	30	4E	42	4A	50
$0A	41	44	75	06	56	30
$0B	27	48	52	31	53	32
$0C	00	00	00	00	00	00
$0D	00	00	00	00	00	00
$0E	00	00	00	00	00	00
$0F	00	00	00	00	00	00
$10	FF	16	F0	00	00	00
$11	81	81	82	7A	7A	7B
$12	91	00	00	3C	3B	00
$13	FF	02	00	00	00	00
$14	1D	1D	00	00	44	40
$15	FA	FA	FA	FA	FA	FA
$16	FA	FA	FA	FA	FA	FA
$17	FA	FA	00	00	00	00
$18	00	0F	05	AC	F1	00
$19	09	00	0A	00	00	64
$1A	00	00	00	00	00	00
$1B	00	00	00	00	00	00
$1C	00	0C	00	00	00	00
$1D	00	00	00	00	00	00
$1F	FD	00	00	00	00	00
$20	FE	FB	00	00	FE	7F
$21	FE	F7	FF	FF	FF	FF
$22	FF	FF	FF	FF	FF	FF
$23	FF	FF	FF	FF	FF	F7
$24	00	00	33	0B	05	03
$25	00	00	00	00	00	00
$26	35	10	08	03	00	00
$27	00	00	00	04	93	44
$28	36	07	50	28	91	00
$29	05	00	00	03	FF	FF
$2A	02	06	0E	19	25	30
$2B	38	3E	42	45	46	00
$2C	00	00	00	0B	FF	16
$2D	FC	A5	00	00	00	00
$30	B2	FE	00	00	FF	FF
$31	FF	FF	FF	FF	FF	FF
$32	FF	FF	FF	FF	FF	FF
$33	FF	FF	FF	FF	FF	FF
$34	00	00	33	08	04	03
$35	00	00	00	00	00	00
$36	00	00	00	00	00	00
$37	00	00	00	00	C8	11
$38	11	07	17	0E	00	00
$39	01	00	00	03	FF	FF
$3A	03	07	0B	0C	0C	0C
$3B	0B	0B	0B	0B	0B	00
$3C	00	00	00	0B	FF	16
$3D	FC	A5	00	00	00	00
$40	40	32	25	20	13	00
$41	00	00	F6	F6	F6	F6
$42	D4	00	44	41	37	2C
$43	1D	00	7D	80	00	00

$44	42	35	36	58	56	00
$45	00	00	F6	F6	F6	F6
$46	F6	00	53	48	2E	40
$47	41	00	80	FE	00	00
$48	55	50	4C	46	42	00
$49	00	00	F6	F6	F6	F6
$4A	F6	00	3B	38	35	32
$4B	53	00	80	FE	00	00
$4C	FF	FF	FF	FF	FF	FF
$4D	FF	FF	FF	FF	FF	FF
$4E	FF	FF	FF	FF	FF	FF
$4F	FF	FF	FF	FF	00	00
$50	FF	FF	FF	FF	FF	FF
$51	FF	FF	FF	FF	FF	FF
$52	FF	FF	FF	FF	FF	FF
$53	FF	FF	FF	FF	FF	FF
$54	FF	FF	FF	FF	FF	FF