TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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ON-SITE CERTIFIED ADVANCED 208 COMPLIANT VEHICLE CRASH INVESTIGATION

GENERAL DYNAMICS CASE NO: CA03-045

VEHICLE: 2003 CHEVROLET TAHOE

LOCATION: ALABAMA

CRASH DATE: JUNE, 2003

Contract No. DTNH22-01-C-17002

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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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VEHICLE: 2003 CHEVROLET TAHOE
LOCATION: ALABAMA
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BACKGROUND

This on-site investigation focused on the performance of the Certified Advanced Compliant (CAC) occupant protection system in a 2003 Chevrolet Tahoe. The manufacturer certified that this vehicle met the requirements of the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. This advanced occupant protection system was comprised of dual-stage frontal air bags, seat track position sensors for both front seats, front safety belt buckle switches, front right passenger air bag suppression switch and a front right occupant detection sensor. The vehicle's Sensing and Diagnostic control Module (SDM) tailored the deployment of the frontal air bags based the crash severity and inputs from these sensors. The Chevrolet Tahoe, **Figure 1**, was involved in a front-to-side intersection crash sequence with a 2002 Chevrolet Silverado 1500 Series pick-up truck. The crash resulted in moderate frontal damage to the Tahoe and warranted the deployment of the vehicle's advanced frontal air bags. The Tahoe was equipped with an Event Data Recorder (EDR) that captured pre-crash and crash data related to the event. The EDR data was downloaded during the inspection and was used as a supplement to the on-site investigation. The Chevrolet Tahoe was occupied by a 32 year old restrained female driver, a 33 year old restrained male front right passenger, a 2 month old female passenger positioned in the second row left, a 2 year old male passenger seated in the second row right, and a 15 year old restrained female in the third row right position. The child passengers seated in the Tahoe's second row were restrained in child safety seats. The driver of the Tahoe sustained a right tibia/fibula fracture (at the ankle) and required hospitalization. The four other occupants in the Tahoe sustained minor severity injuries; however, they did not require medical attention. The 19 year old male driver of the Chevrolet Silverado suffered a police reported visible injury and was transported to a hospital.

Figure 1: Right front view of the Chevrolet Tahoe.

The Crash Investigation Division of the National Highway Traffic Safety Administration received notification of this June 2003 crash and assigned an on-site crash investigation to the Special Crash Investigations team at General Dynamics on August 7, 2003. The case was assigned due to the agency's interest in the field performance of vehicles equipped with these advanced safety systems. The Chevrolet Tahoe was considered a total loss by its insurance carrier and cooperation was established with the adjuster handling the claim. It was located in an

insurance salvage yard and was available for inspection. The Chevrolet Silverado was sold for salvage prior to SCI involvement and was not available for inspection.

VEHICLE DATA

2003 Chevrolet Tahoe

The 2003 Chevrolet Tahoe was identified by the Vehicle Identification Number (VIN): 1GNEC13Z23J (production sequence deleted). The two wheel drive, four door sport utility was configured with a 295 cm (116 in) wheelbase. The Gross Vehicle Weight Rating (GVWR) was 3,084 kg (6,800 lb). The power train consisted of a 5.3 liter/V8 engine linked to a four-speed automatic transmission with overdrive. The vehicle was equipped with LT model trim equipment to include power steering, power assist four-wheel disc brakes with ABS, power windows and door locks, and adjustable pedals. The interior was configured for seven passenger seating (2/2/3). The front row consisted of leather trimmed ten-way power adjustable front bucket seats. The second row was equipped with leather trimmed non-adjustable bucket seats. The third row consisted of a 50/50 split bench seat. The manual restraint system consisted of seat-integrated 3-point lap and shoulder belts in the outboard positions of the first and third row. The second row manual restraints consisted of continuous loop 3-point lap and shoulder belts with C-pillars mounted switchable retractors. The third row center position was lap belt equipped. The Supplemental Restraint System consisted of driver and front right passenger air bags certified to be compliant with the advanced FMVSS 208 occupant protection standard. The vehicle's date of manufacture was January 2003. The driver reported that the vehicle was purchased approximately two months prior to the crash. She further reported the odometer reading was approximately 2,897 km (1,800 miles) at the time of the crash. The Tahoe was equipped with Firestone Wilderness LE P265/70R16 tires on OEM alloy wheels. The manufacturer's recommended tire pressure was 241 kpa (35 psi). The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	231.0 kpa (33.5 psi)	7.1 mm (9/32)	Yes	None
LR	231.0 kpa (33.5 psi)	6.4 mm (8/32)	Yes	None
RF	231.0 kpa (33.5 psi)	7.1 mm (9/32)	No	None
RR	231.0 kpa (33.5 psi)	5.6 mm (7/32)	No	None

2002 Chevrolet Silverado 1500 Series Pick-Up Truck

The 2002 Chevrolet Silverado 1500 Series pick-up truck was identified by the Vehicle Identification Number (VIN): 2GCEC19T921 (production sequence deleted). The Chevrolet pick-up truck was a 4x2, 454 kg (1/2 ton), four-door extended cab model. The power train consisted of a 5.3 liter/V8 engine and 4-speed automatic transmission. The service brakes consisted of four-wheel disc with ABS. This vehicle was sold for salvage prior to SCI involvement in this investigation and was not inspected.

SUMMARY

Crash Site

This two-vehicle crash occurred during the afternoon hours in June, 2003. At the time of the crash, it was daylight. The weather was clear and was not a factor in the crash. The asphalt road surface was dry. The crash occurred at the intersection of an east/west state highway and a north/south local road. There was a large radius left curve for the eastbound traffic throughout the crash site. At the intersection, the state highway was configured with seven lanes (four lanes eastbound/three lanes westbound). The opposing traffic lanes were separated by a 2 m (6 ft) wide, depressed concrete median. The eastbound lanes consisted of a right turn only lane, two lanes carrying traffic through the intersection and a left turn only lane. The north/south road consisted of two lanes. The intersection was controlled by stop signs for the north/south traffic. The speed limit in the area of the crash was 89 km/h (55 mph). A 3 m (10 ft) deep drainage area was located in the southeast quadrant of the intersection. A convenience store and service station were located immediately south of the drainage area. **Figures 2 and 3** are eastbound and southbound views of the intersection.

Figure 2: Eastbound view approaching the intersection.

Figure 3: Southbound view of the intersection.

CRASH SEQUENCE

Pre-Crash

The 2003 Chevrolet Tahoe was eastbound in the outboard through lane driven by a 32 year old female driver. She was restrained at the time of the crash by the manual 3-point lap and shoulder belt system. The Tahoe was occupied by a restrained 33 year old male front right passenger, a 2 month old female passenger seated in the second row left, a 2 year old male passenger seated in the second row right, and a 15 year old restrained female in the third row right position. The child passengers seated in the Tahoe's second row were restrained in child safety seats. The driver estimated her speed was approximately 97-105 km/h (60-65 mph). She did not recall detecting the Chevrolet Silverado until immediately before impact. She believed she had time to apply the brakes. The downloaded EDR data recorded the speed of the Tahoe to be 105 km/h

(65 mph) for the five second period prior to Algorithm Enable (AE). The data further indicated the brakes were activated one second prior to AE.

The 2002 Chevrolet Silverado was stopped at the intersection heading south. The Silverado was driven by a 19 year old restrained male. The driver accelerated the Silverado forward, attempting to cross the intersection, precipitating the crash. No pre-crash tire marks were identified during the police and on-site SCI investigation.

Crash

The southbound Chevrolet Silverado crossed directly into the path of the eastbound Chevrolet Tahoe. The front plane of the Tahoe impacted the right side plane of the Silverado in a T-configuration impact The principle directions of the impact force were 11 and 2 o'clock for the Tahoe and Silverado, respectively. A 36 cm (14 in) black scuff mark was identified on the right aspect of the Tahoe's front bumper and was attributed to contact with the right front tire of the Silverado at impact. This physical evidence indicated the Tahoe struck the Silverado in the area of the right front fender and right front door. The force of the impact caused the CAC frontal air bags of the Tahoe to deploy. The frontal air bags in the Silverado also deployed. The Tahoe's EDR recorded a maximum longitudinal delta V of -33.3 km/h (-20.7 mph) for this event.

The eastbound momentum of the Tahoe and its impact forward of the Silverado's center of gravity caused the Silverado to rotate counterclockwise and the vehicles contacted again in a minor sideslap configuration. The vehicles separated from the secondary impact with a southeast trajectory. The Tahoe entered the southeast quadrant of the intersection and came to rest against the concrete base support for an overhead light, 23 m (75 ft) from the initial impact. The undamaged concrete base support measured 71 cm (28 in) in diameter and measured 43 cm (17 in) in height. The undamaged light pole measured 30 cm (12 in) in diameter and was 9 m (30 ft) tall. The Silverado departed the south road edge and drove down into the drainage area south of the road. The Silverado came to rest against the ditch embankment approximately 35 m (115 ft) from the initial point of impact. The area of the final rest locations of the vehicles is depicted in **Figure 4**. **Figure 5** is a close-up view of the concrete base support. A schematic of the crash sequence is included as **Figure 16** at the end of this narrative report.

Figure 4: View of the SE intersection quadrant and the area of final rest.

Figure 5: View of the concrete base support.

Post-Crash

The police and ambulance personnel were called to the scene. A physician passing by the crash site stopped and also rendered assistance. The 33 year old front right male passenger and 15 year old female passenger of the Tahoe exited the vehicle and were ambulatory at the scene. Both occupants complained of soreness. The driver of the Tahoe remained within the vehicle until the arrival of the medical personnel. She was removed from the vehicle and transported to the emergency room of a local hospital. Diagnostic X-rays determined she sustained a fracture of the right tibia and fibula (at the ankle). At her request, she was transferred and admitted to another hospital closer to her residence. The physician (passing by the crash) checked the status of the Tahoe's 2 month old female passenger and 2 year old male passenger. Neither child was injured. The 19 year old driver of the Silverado was reportedly transported via ambulance for a police reported visible injury.

EXTERIOR DAMAGE

2003 Chevrolet Tahoe

The Tahoe reportedly was involved in two frontal impacts; namely, the vehicle-to-vehicle crash with the Silverado and the vehicle-to-fixed object crash with the concrete base support. Although the Tahoe did contact the concrete base support, it has been determined to a reasonable degree of certainty that the contact with the concrete support did not alter the frontal crush profile of the Tahoe. This conclusion is based on an analysis of the damage profile to the Tahoe and the lack of damage to the concrete base. The Tahoe simply came to rest against the concrete base. Additionally, the Tahoe's EDR would have recorded a non-deployment event related to an impact with the base support had it been significant. The analysis of the EDR data indicated the stored non-deployment event was related to the minor secondary side-slap. Refer to the Event Data Recorder Attachment for further detail.

Figures 6 through 8 are the front, left side, and right lateral views of the Chevrolet Tahoe. The Tahoe's front plane sustained 167.6 cm (66.0 in) of direct contact damage that extended across its entire front end width. The damaged components included: the front bumper system, radiator, air conditioning condenser, headlamp assemblies, hood, and the left and right fenders. The residual crush profile measured along the front bumper was as follows: C1 = 26.0 cm (10.2 in), C2 = 31.0 cm (12.2 in), C3 = 42.0 cm (16.5 in), C4 = 43.0 cm (16.9 in), C5 = 23.0 cm (9.1 in), C6 = 23.0 cm (9.1 in). The maximum crush measured 49.0 cm (19.3 in) and was located 9.1 cm (3.6 in) right of vehicle centerline. The lateral momentum of the Silverado at engagement caused 30 cm (12 in) right end shift to the Tahoe. A 36 cm (14 in) black scuff mark was identified on the right aspect of the bumper cover. The scuff was attributed to contact with the right front tire of the Silverado at impact. The left and right wheelbase measurements were reduced 2.5 cm (1.0 in) and 18.0 cm (7.1 in), respectively. The lower aspect of the windshield fractured from the exterior crash force. The left front window glazing disintegrated. All the doors remained closed during the impact and were operational at inspection. The principle direction of the impact force was in the 11 o'clock sector. The Collision Deformation Classification was 71-FDEW-2. (The CDC was incremented by 60 to reflect the right end shift of the damage.) The total delta-V of the Tahoe calculated by the Missing Vehicle Algorithm of the WINSMASH model was 40 km/h (24.8 mph). The longitudinal and lateral components of the delta-V were -34.7 km/h (-21.6 mph) and 20.0 km/h (12.4 mph), respectively. The calculated

longitudinal delta-V component was in agreement with the -33.3 km/h (-20.7 mph) delta-V recorded by the Tahoe's EDR.

Figure 6: Front view of the Tahoe.

Figure 7: Left side view.

Figure 8: Right lateral view.

The left side of the Tahoe sustained localized abrasions and paint transfers to the body panels that extended from the left front fender to the left rear quarterpanel as a result of the secondary sideslap engagement with the Silverado. Additionally, the left rear quarterpanel was deformed immediately above of the left rear tire over a 65.5 cm (25.8 in) length from direct contact with the right rear corner of the Silverado. The maximum crush within the deformed area measured 5.6 cm (2.2 in) and was located 14.5 cm (5.7 in) aft of the left rear axle. The CDC of the side slap engagement was 09-LDMW-1.

INTERIOR DAMAGE

2003 Chevrolet Tahoe

The interior damage to the Chevrolet Tahoe consisted of the deployment of the vehicle's CAC frontal air bag system and the minor interior occupant contacts. There was no intrusion into the driver's occupant space. The intrusion into the front right footwell measured 2.5 cm (1.0 in).

There was no evidence of contact to the driver's knee bolster. The release handle for the parking brake, mounted below the lower aspect of the panel, was displaced (slightly rotated). The handle was possibly contacted by the driver's left lower extremity; however, this contact did not result in an injury. There was no contact evidence noted on the glove box/bolster area for the front right passenger. The lack of occupant contacts supported the fact that the driver and front right passenger were restrained by the integrated safety belts at the time of the crash.

The 4-spoke, tilt steering wheel was adjusted to the full-down position. The steering wheel was rotated 90 degrees counterclockwise at inspection. There was no deformation of the steering wheel rim and there was no evidence of loading to the steering column's shear capsules. The Tahoe was equipped with adjustable foot pedals. The pedals were adjusted to the rearmost position (closest to the driver) at inspection.

The powered, ten-way adjustable driver seat was located in a mid-track position at the time of the inspection. The seat position measured 9.4 cm (3.7 in) rearward of full forward. The total seat track travel measured 21.6 cm (8.5 in). The seat back angle measured 30 degrees aft of vertical. The horizontal distance from the center of the air bag module to the seat back measured 52.1 cm (20.5 in). This distance was measured 41 cm (16 in) above the seat bight. There was no contact or loading to the back aspect of the seat back from the child safety seat in the second row left position.

The powered, ten-way adjustable front right seat was located in a mid-track position at the time of the inspection. The seat position measured 8.9 cm (3.5 in) rearward of full forward. The total seat track travel measured 21.6 cm (8.5 in). The seat back angle measured 23 degrees aft of vertical. The horizontal distance from the vertical face of the mid-mount air bag module to the seat back measured 77.5 cm (30.5 in). This distance was measured 48 cm (19 in) above the seat bight. There was no contact or loading to the back aspect of the seat back from the 2 year old male child seated in the forward facing convertible child restraint.

The second row seating of the Tahoe was comprised of two non-adjustable bucket seats. These two seats were Lower Anchors and Tethers for Children (LATCH) compatible. The third row seating was comprised of a 3-passenger 50/50 split bench seat. These seats did not have the LATCH lower anchors but the seat frame had provisions for a tether attachment in the center position. The left side of the split bench was folded forward and stowed at the time of the inspection. There was no interior damage in the second or third rows of the Tahoe.

MANUAL RESTRAINT SYSTEM
2003 Chevrolet Tahoe

The manual restraint system in the front row of the Tahoe consisted of integrated 3-point lap and shoulder belts with continuous loop webbing and sliding latch plates. The driver's restraint was stowed within the ELR retractor upon inspection. Examination of the latch plate revealed minor indications of historical use consistent with the age of the vehicle. Inspection of the webbing revealed crash related evidence at the latch plate and belt guide of the integrated restraint consistent with the restraint being worn at the time of the crash, **Figure 9**. A crease in the webbing from loading at the latch plate was located 75.0 cm (29.5 in) above the outboard anchor. A webbing crease was identified at the belt guide with the webbing extended and buckled. The location of the crease measured 127.5 cm (50.2 in) from the outboard anchor. The SCI inspection determined the driver was restrained at the time of the crash. This determination was consistent with the downloaded EDR data; the EDR data indicated the driver restraint was buckled at the time of the crash.

The front right passenger's integrated restraint was stowed at the time of the inspection. Examination of the latch plate revealed historical usage marks consistent with the vehicle's age. Crash related evidence was identified on the extended webbing consistent with the restraint being used at the impact, **Figure 10**. A crease in the webbing from the latch plate loading was located 75.7 cm (29.8 in) above the outboard anchor and a crease in the webbing was located 163 cm (64 in) above the anchor at the belt guide. A 16.5 cm (6.5 in) abrasion was noted on the body side of the restraint webbing. The abrasion began 122 cm (48 in) above the anchor. All evidence gathered at the SCI inspection indicated the front right passenger was restrained at the time of the crash.

Figure 9: Driver's restraint.

Figure 10 Front right passenger's restraint.

The manual restraint system in the second row of the Tahoe consisted of 3-point lap and shoulder belts with continuous loop webbing, sliding latch plates and C-pillar mounted switchable retractors. An Evenflo Port-About Infant child safety seat occupied by a 2 month old female was restrained in the left seat of the Tahoe's second row at the time of the crash. The driver (mother)

reported that she had installed the infant seat in a rear-facing direction using both the latch belt and the vehicle's manual restraint. She further stated that she installed the seat utilizing the switchable retractor. She was familiar with child seat installation with through experience (this was her second child). She reported that she had read the vehicle's owner's manual regarding the operation of the switchable retractors and routed the belt using the labeling on the restraint. Upon inspection, the manual restraint, **Figure 11**, was stowed within the retractor and the retractor was operational. Examination of the latch plate revealed historical use consistent with the vehicle's age. A 1.2 cm (0.5 in) crease of the webbing located 26.7 cm (10.5 in) above the outboard anchor was identified. This crease was attributed to probable contact with the base of the infant restraint at the time of the crash. A 5 cm (2 in) longitudinal crease of unknown origin was located 112 – 117 cm (44 - 46 in) above the anchor.

Figure 11: Second row left seat.

A Britax Roundabout convertible child safety seat was installed in the right position of the Tahoe's second row. The child seat was occupied by a 2 year old male. The driver reported that she installed the seat using the vehicle's manual restraint and had utilized the switchable retractor to lock the belt. A tether was routed under the head restraint and attached to the tether anchor location on the back of the seat. Upon inspection, the webbing of this manual restraint was stowed within its retractor and the retractor was operational. The latch plate revealed minor evidence of historical use. Examination of the webbing was unremarkable. No crash related evidence was identified.

The manual restraint system in the third row of the Tahoe consisted of integrated manual 3-point lap and shoulder belts in the outboard positions. The center rear position was lap belt equipped. The right position of the third row was occupied by a 15 year old restrained female. Upon examination, the restraint webbing was stowed within the retractor. Examination of the latch plate revealed minor historical use evidence. Extension and examination of the webbing was unremarkable. No crash related evidence was identified.

CERTIFIED ADVANCED COMPLIANT FRONTAL AIR BAG SYSTEM
2003 Chevrolet Tahoe

The frontal air bags in the 2003 Chevrolet Tahoe were certified as compliant with the advanced FMVSS 208 ruling. The deployment of the dual-stage air bags was controlled by a Sensing and Diagnostic Module (SDM) that had Event Data Recording (EDR) capabilities. The EDR was downloaded as a supplement to this investigation. The SDM assessed the severity of the crash and tailored the air bag deployment based on input from following: seat position sensors (for both the driver and the front right passenger seats), front right passenger detection sensor, seat belt buckle switches, and a seat belt tension retractor sensor (for the front right manual restraint). In this crash, both Stages of the dual-stage frontal air bags deployed. The Stage 1 frontal air bag

deployment was commanded 5 milliseconds after Algorithm Enable (AE). The Stage 2 deployment command occurred 17.5 milliseconds after AE.

The driver air bag module was located in the center hub of the steering wheel. The symmetrical I-configuration module cover flaps measured 6.4 cm x 11.7 cm (2.5 in x 4.6 in), width by height. The flaps opened along the designated tear seams and were not damaged. There was no evidence of occupant contact to the flaps. The diameter of the deployed driver air bag, **Figure 12**, measured 64 cm (25 in) in its deflated state. It was tethered by two 8 cm (3 in) wide straps and vented by two ports located in the 11/1 o'clock sectors on the back side of the bag. A 5 cm x 13 cm (2 in x 5 in) scuff was identified in the 1 o'clock sector on the face of the bag. The center of the scuff was located 15 cm (6 in) from the center of the bag. A (post-crash) blood transfer was noted within the scuffed area. The scuffed area was attributed to contact with the driver's chest and face during the ride-down of the crash. The contact to the driver air bag resulted in a minor forehead abrasion.

Figure 12: Driver air bag. Note the 90 degree CCW rotation of the steering wheel.

The front right passenger air bag was a mid-mount design located in the right aspect of the instrument panel. The module cover flap was rectangular and measured 38 cm x 11.4 cm (15 in x 4.5 in), width by height. The vinyl cover flap was hinged along its top edge and opened along the designated tear seams. There was no occupant contact to the cover flap. The face of the deployed front right passenger air bag, **Figure 13**, measured 64 cm x 71 cm (25 in x 28 in). The rearward excursion of the bag measured 56 cm (22 in). The bag was tethered by a 30 cm (12 in) wide strap and vented by two 2.5 cm (1.0 in) ports located on the side panels. A 3.8 cm x 5.1 cm (1.5 in x 2.0 in) area of blood and body fluid (nasal expulsion) was located on the centerline of the air bag 5.1 cm (2.0 in) below the tethered stitching. This evidence was attributed to direct contact with the face of the front right occupant during the ride-down of the crash. A post-crash blood transfer was located on the right aspect of the bag's top surface, 5 cm (2 in) forward of the face of the bag. The front right passenger reportedly wore prescription glasses and sustained a bloody nose as a result of the contact to the air bag.

Figure 13: View of the PAB.

CHILD SAFETY SEAT DATA

At the time of the crash, the 2 month old infant was transported in an Evenflo Port-About rear-facing infant carrier with a detachable base, **Figure 14**. The infant seat's date of manufacture was 17-Feb-2003 and the Model Number was *3741351 P1*. This seat had been purchased new, approximately one week before the birth of this child. The carrier was designed for infants with a weight and height of 2.3 - 10 kg (5 – 22 lb) and 48 - 66 cm (19 - 26 in). It was equipped with a 3-point harness and two piece chest clip. The harness was routed through the middle slots in the carrier. Comfort sleeves were added to the harness for extra padding at the infant's shoulders. The driver estimated the harness was at the level of the infant's shoulders.

Figure 14: View of the infant carrier.

The detachable base had an adjustable foot to control the installed angle of the seat and it was equipped with a latch belt. The driver (mother) installed the seat and was familiar with the installation by experience and by referring to the labeling. The infant seat was installed in the left position of the second row. A folded towel was placed under the foot and the foot was adjusted to its mid position. The base was installed using both the latch belt and with the vehicle's 3-point safety belt utilizing the switchable retractor. The driver indicated she compressed the seat while tightening the belts. She noted the angle indicator for the carrier was in the "green". Inspection of the seat was unremarkable. The cloth cover was fully removed and inspected for damage. There was no evidence of damage to the shell or to the harness.

The 2 year old male was transported in a Britax Roundabout convertible seat, **Figure 15**. This seat had a manufacture date of May 14, 2001. The Model, Serial, and Batch numbers for the seat were as follows: *E900230, E9002304088, 501063.* The seat was designed for rear-facing use by infants 2.3 - 14 kg (5 – 30 lb) and for forward facing use by toddlers 9 – 18 kg (20 – 40 lb). The seat was equipped with a 5-point harness, two-piece chest clip, and a tether strap. The harness straps were routed through the top slots of the seat. The driver indicated that the seat was purchased new for the birth of this male child and had been used routinely since his birth.

Figure 15: View of the convertible seat.

The driver indicated she installed the seat in a forward facing mode in the right position of the second row. The vehicle's safety belt was routed through the forward facing belt path as described by the labeling and secured utilizing the switchable retractor. The driver indicated she compressed the seat with her knee and pulled the vehicle belt webbing tight. The tether strap

was routed under the head restraint and attached to the tether anchor on the seat frame. Inspection of the seat was unremarkable. There was no damage identified on the shell of the seat or the harness straps.

The child seats were inspected approximately four months after the crash due to the delay in SCI notification. During that time, the seats were being routinely used by the family. The driver was aware that a child seat should be replaced after a crash; however, their insurance company denied the reimbursement claim for the seats.

OCCUPANT DEMOGRAPHICS
2003 Chevrolet Tahoe

	Driver	***Front Right Passenger***
Age/Sex:	32 year old/Female	33 year old/Male
Height:	160 cm (63 in)	173 cm (68 in)
Weight:	54 kg (120 lb)	91 kg (200 lb)
Seat Position:	Mid track	Mid track
Restraint Use:	3-point lap and shoulder belt	3-point lap and shoulder belt
Usage Source:	SCI inspection, EDR	SCI inspection
Medical Treatment:	Three days hospitalization, right ankle fracture	Examined on-scene and released

	Second Row Left	***Second Row Right***
Age/Sex:	2 month old/Female	2-year old/Male
Height:	54.6 cm (21.5 in)	84 cm (33 in)
Weight:	5 kg (11 lbs)	11 kg (24 lb)
Seat Position:	Fixed track	Fixed track
Restraint Use:	Rear facing child safety seat with 3 pt. harness	Forward facing child safety seat with 5 pt. harness
Usage Source:	SCI inspection, interview	SCI inspection, interview
Medical Treatment:	Examined on-scene and released	Examined on-scene and released

	Third Row Left/Middle	***Third Row Right***
Age/Sex:		15 year old/Female
Height:		170 cm (67 in)
Weight:		52 kg (115 lb)
Seat Position:	Not Occupied	Fixed track
Restraint Use:		3point lap and shoulder belt
Usage Source:		SCI inspection, interview
Medical Treatment:		Examined on-scene and released

DRIVER INJURY
2003 Chevrolet Tahoe

Injury	*Injury Severity (AIS 98 Update)*	*Injury Mechanism*
Right tibia and fibula fracture, (at the ankle fracture), NFS	Moderate (851605.2,1) (853404.2,1)	Brake pedal
Left forehead abrasion	Minor (290202.1,7)	Deployed driver air bag

Note: the above injuries were identified in the Discharge Summary for the driver's hospitalization. The medical records were not clear as to exact site of the fracture, but it did indicate the ankle was involved.

DRIVER KINEMATICS
2003 Chevrolet Tahoe
The 32 year old female driver of the Chevrolet was seated in a normal posture in a mid-track position. She was restrained by the manual 3-point lap and shoulder belt system. The driver reported that she was aware of the impending crash, and braked the Tahoe with her right foot immediately prior to the crash. This action confirmed by the pre-crash data recorded by the EDR.

Upon impact with the Chevrolet pick-up truck, the frontal air bags deployed. The driver initiated a forward trajectory in response to the 11 o'clock direction of the impact and loaded the manual restraint. Her inertial reaction also caused her to load her right ankle resulting in the fracture of the tibia and fibula. The driver rode down the crash forces through the manual restraint her upper chest and face contacted the deployed driver air bag. This contact was evidenced by a scuff to the driver air bag and an abrasion to the left aspect of the driver's forehead. The driver then rebounded back into her seat where she came to rest.

FRONT RIGHT PASSENGER INJURY
2003 Chevrolet Tahoe

Injury	*Injury Severity (AIS 98 Update)*	*Injury Mechanism*
Nose bleed, epitasis	Minor (251090.1,4)	Deployed front right passenger air bag

Note: the above injury was identified via driver interview.

FRONT RIGHT PASSENGER KINEMATICS
2003 Chevrolet Tahoe
The 33 year old male front right passenger was restrained at the time of the crash and seated in a mid track position with an upright posture. At impact, he initiated a forward trajectory in response to the 11 o'clock direction of the impact and loaded the manual restraint system. His face contacted the deployed front right air bag as evidenced by the identified blood and nasal

expulsion. This contact resulted in a nose bleed. The passenger then rebounded back into this seat.

SECOND ROW LEFT PASSENGER INJURY
2003 Chevrolet Tahoe
The 2 month old restrained rear-facing infant was not injured in the event.

SECOND ROW LEFT PASSENGER KINEMATICS
2003 Chevrolet Tahoe
The 2 month old female infant was restrained by in a rear-facing infant seat buckled into the left seat of the Tahoe's second row. At impact, the infant initiated a forward trajectory in response to the 11 o'clock direction of force. The infant loaded the shell of the child restraint with his back and rode down the force of the crash. He came to rest within the child restraint. A physician passing by the crash site examined the infant prior to her removal from the restraint. She was not injured in the crash.

SECOND ROW RIGHT PASSENGER INJURY
2003 Chevrolet Tahoe
The 2 year old restrained forward facing child was not injured in the event.

SECOND ROW RIGHT PASSENGER KINEMATICS
2003 Chevrolet Tahoe
The 2 year old male was restrained by the 5-point harness of a convertible child safety seat buckled in the left position of the Tahoe's second row. Upon impact, the child initiated a forward trajectory in response to the 11 o'clock direction of the impact force and loaded the harness straps of the safety seat. The child rode down the crash force and rebounded into his seat without contacting any interior components. He was examined prior to his removal from the vehicle by a physician rendering aid at the crash site and was found to be uninjured.

THIRD ROW RIGHT PASSENGER
2003 Chevrolet Tahoe
The 15 year old restrained female was not injured in the crash.

THIRD ROW RIGHT PASSENGER KINEMATICS
2003 Chevrolet Tahoe
The 15 year old female passenger was seated with a presumed normal posture and was restrained by the vehicle's integrated 3-point lap and shoulder belt. Upon impact, she initiated a forward trajectory and loaded the manual restraint. The use of the restraint allowed the occupant to ride down the force of the crash without contacting any interior components. She exited the vehicle and was not injured.

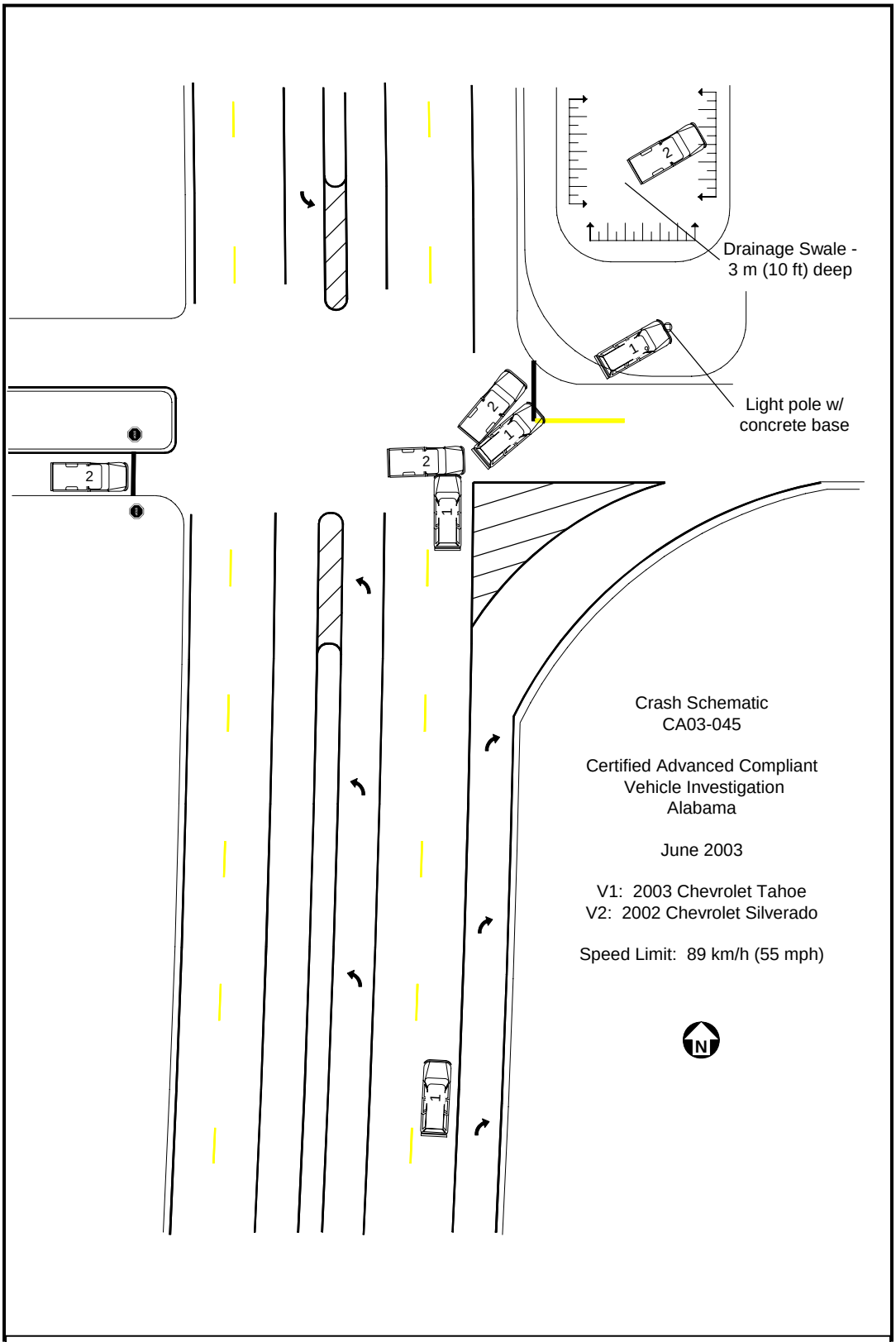


Figure 16: Crash schematic.

ATTACHMENT A

EDR Data

CDR File Information

Vehicle Identification Number	1GNEC13Z23Jxxxxxx
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	CA03-045 NO SEQ.CDR
Saved on	Tuesday, August 19 2003 at 10:13:45 AM
Data check information	6A7C4C3B
Collected with CDR version	Crash Data Retrieval Tool 2.10
Collecting program verification number	B6B4FDF8
Reported with CDR version	Crash Data Retrieval Tool 2.24
Reporting program verification number	70CD83DD
Interface used to collected data	Block number: 00 Interface version: 35 Date: 01-02-03 Checksum: 6200
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). 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.

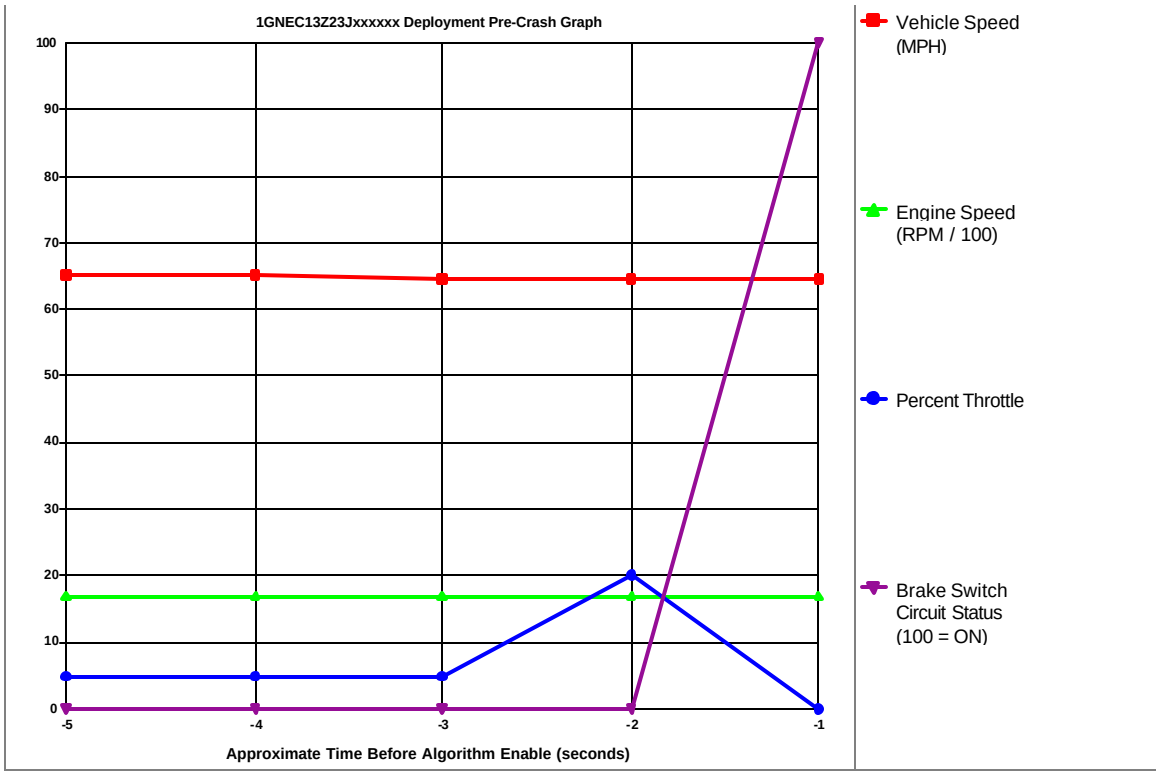
SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change is one of the measures used to make air bag deployment decisions. SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM 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

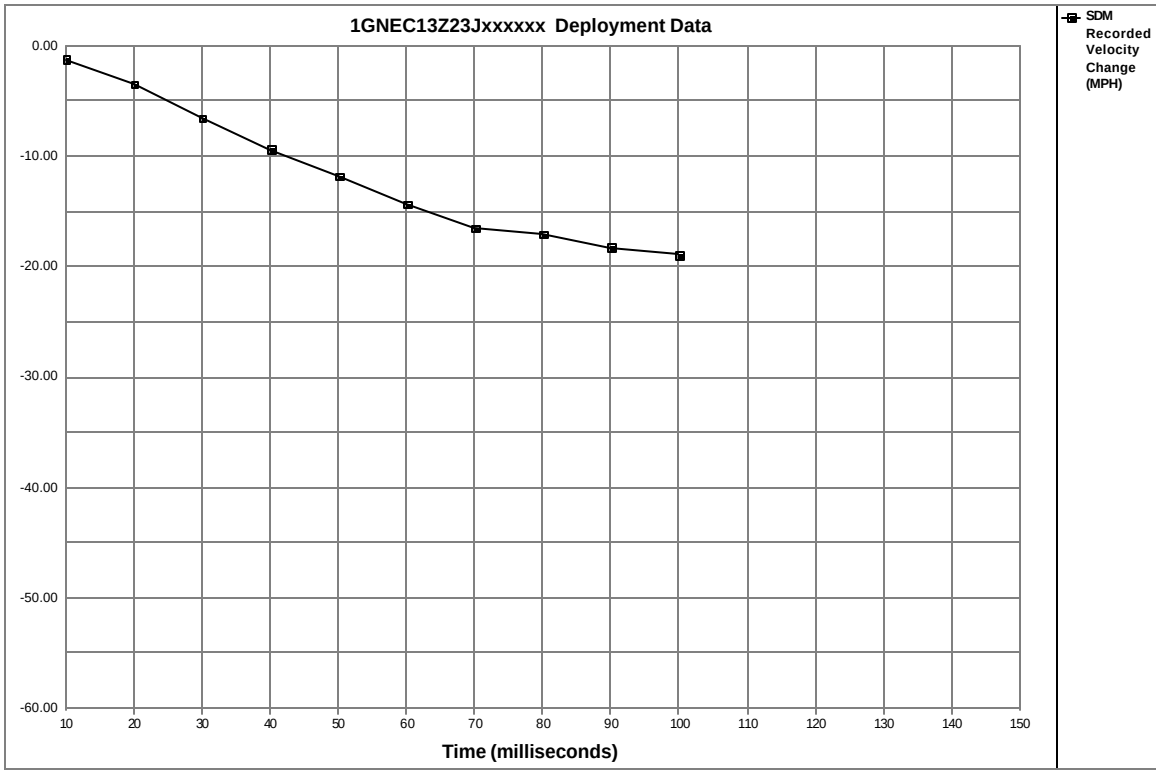
the SDM.
-In most vehicles, the Driver's Belt Switch Circuit is wired directly to the SDM. In some vehicles, the Driver's Belt Switch Circuit Status data is transmitted from the Body Control Module (BCM), via the Class 2 data link, to the SDM.

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	316
Ignition Cycles At Investigation	317
Maximum SDM Recorded Velocity Change (MPH)	-20.70
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	150
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	17.5
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	5
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	17.5
Time Between Non-Deployment And Deployment Events (sec)	N/A
Frontal Deployment Level Event Counter	1
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No



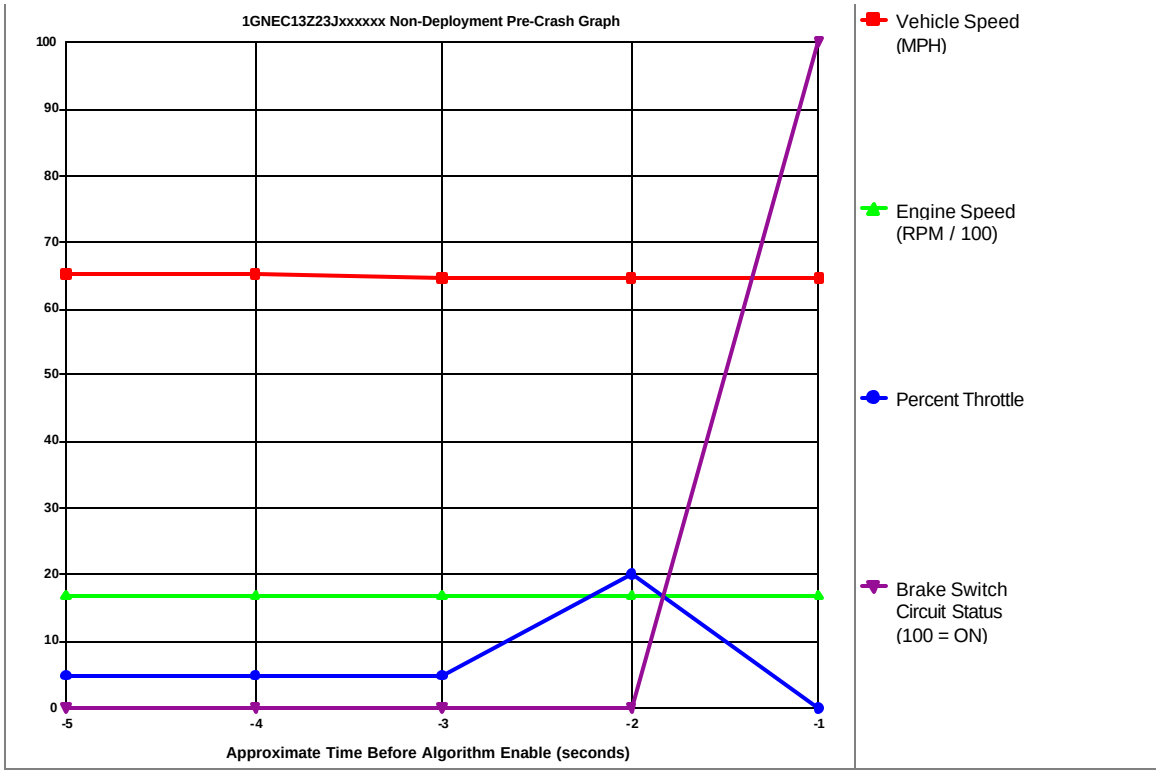
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	65	1728	5	OFF
-4	65	1728	5	OFF
-3	65	1728	5	OFF
-2	65	1728	20	OFF
-1	65	1664	0	ON



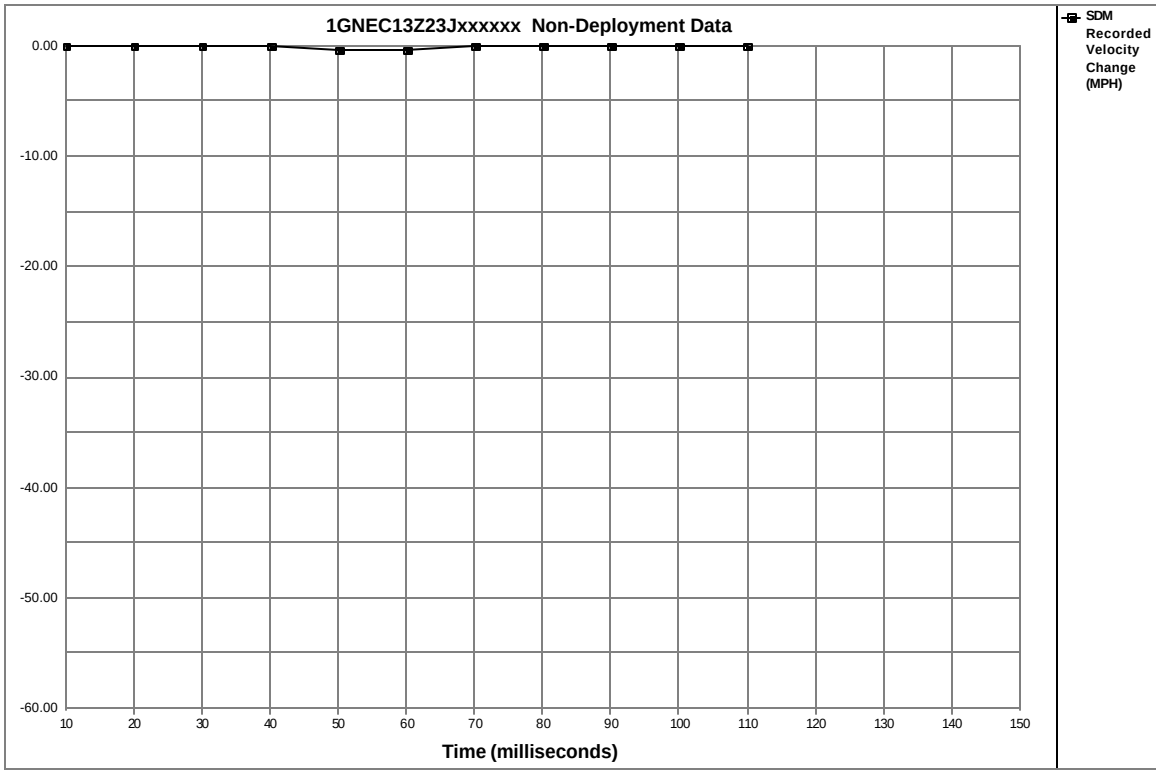
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-1.24	-3.41	-6.51	-9.30	-11.78	-14.26	-16.43	-17.05	-18.29	-18.91	N/A	N/A	N/A	N/A	N/A

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	316
Ignition Cycles At Investigation	317
Maximum SDM Recorded Velocity Change (MPH)	-0.35
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	60
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	65	1728	5	OFF
-4	65	1728	5	OFF
-3	65	1728	5	OFF
-2	65	1728	20	OFF
-1	65	1664	0	ON



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	0.00	0.00	0.00	0.00	-0.31	-0.31	0.00	0.00	0.00	0.00	0.00	N/A	N/A	N/A	N/A

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 31 36
$04  4B 35 30 55 48 31
$05  00 00 00 00 00 00
$06  15 19 24 48 00 00
$07  00 00 00 00 00 00
$08  00 00 00 00 00 00
$09  00 00 00 00 00 00
$0A  00 00 00 00 00 00
$0B  00 00 00 00 00 00
$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 D8 E0 00 00 00
$11  82 80 83 7E 7C 7F
$12  8A 78 7B 20 20 01
$13  FF 02 00 00 00 00
$14  01 01 00 00 6C 00
$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  FE 00 00 00 00 00
$20  52 FD 00 00 FF FF
$21  FF F7 FF FF FF FF
$22  FF FF FF FF FF FF
$23  FF FF FF FF FF F7
$24  00 00 12 00 18 17
$25  4F 00 00 03 00 00
$26  00 00 00 00 01 01
$27  00 00 00 00 00 00
$28  00 00 00 0B FF D8
$29  F0 A5 FF FF FF FF
$2A  FF FF FF FF FF FF
$2B  FF FF FF FF FF FF
$2C  FF FF FF FF FF FF
$2D  FF FF 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 05 02 03
$35  00 33 05 02 03 00
$36  35 0E 07 03 00 35
$37  0E 07 03 04 2B 46
$38  3C 03 50 30 00 00
```

$39	0F	00	00	03	00	00
$3A	04	0B	15	1E	26	2E
$3B	35	37	3B	3D	00	00
$3C	00	00	00	0A	FF	D8
$3D	F0	A5	00	00	00	00
$40	68	68	68	69	69	00
$41	80	00	00	32	0D	0D
$42	0D	00	1A	1B	1B	1B
$43	1B	00	27	FC	00	00
$44	68	68	68	69	69	00
$45	80	00	00	32	0D	0D
$46	0D	00	1A	1B	1B	1B
$47	1B	00	80	FE	00	00
$48	68	68	68	69	69	00
$49	80	00	00	32	0D	0D
$4A	0D	00	1A	1B	1B	1B
$4B	1B	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
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$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