**TRANSPORTATION SCIENCES**
**CRASH DATA RESEARCH CENTER**

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# GENERAL DYNAMICS ON-SITE CERTIFIED ADVANCED-208 COMPLIANT VEHICLE CRASH INVESTIGATION

**SCI CASE NO. – CA04-013**

**SUBJECT VEHICLE – 2003 CHEVROLET AVALANCHE**

**LOCATION - STATE OF TENNESSEE**

**CRASH DATE – FEBRUARY 2004**

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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

| | | | |
|---|---|---|---|
| *1. Report No.*<br>CA04-013 | *2. Government Accession No.* | *3. Recipient's Catalog No.* | |
| *4. Title and Subtitle*<br>General Dynamics On-Site Certified Advanced-208 Complaint Vehicle Crash Investigation<br>Location: State of Tennessee | | *5. Report Date*:<br>May 2004<br><br>*6. Performing Organization Code* | |
| *7. Author(s)*<br>Crash Data Research Center | | *8. Performing Organization Report No.* | |
| *9. Performing Organization Name and Address*<br>Transportation Sciences<br>Crash Data Research Center<br>Advanced Engineering Services, Inc.<br>A General Dynamics Company<br>P.O. Box 400<br>Buffalo, New York 14225 | | *10. Work Unit No.*<br>C00410.0000.0194<br><br>*11. Contract or Grant No.*<br>DTNH22-01-C-17002 | |
| *12. Sponsoring Agency Name and Address*<br>U.S. Department of Transportation<br>National Highway Traffic Safety Administration<br>Washington, D.C. 20590 | | *13. Type of Report and Period Covered*<br>Technical Report<br>Crash Date: February 2004<br><br>*14. Sponsoring Agency Code* | |
| *15. Supplementary Note*<br>This on-site investigation focused on the performance of the Certified Advanced-208 Compliant (CAC) safety system in a 2003 Chevrolet Avalanche. | | | |
| *16. Abstract*<br>This on-site investigation focused on the performance of the Certified Advanced-208 Compliant (CAC) safety system in a 2003 Chevrolet Avalanche. A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard No. 208. The safety system included dual stage frontal air bags, seat track position sensors for the front seats, an occupant detection sensor for the front right seat, and safety belt switch sensors. The frontal air bags deployed during the crash sequence. In addition to the CAC features, the Chevrolet was equipped with seatback mounted side impact air bags for the front seats that did not deploy and an Event Data Recorder that was downloaded (Deployment and Non-Deployment) during the on-site investigative effort. The EDR printout is included as **Attachment A** of this report. The Chevrolet was occupied by an unrestrained 36-year-old female driver and an unrestrained 11-year-old female front right occupant. The Chevrolet was involved in a run-off-road collision where the undercarriage impacted an earth embankment and the front impacted several small diameter trees. The front right area impacted a large diameter tree that deployed the frontal air bags. The driver sustained minor injuries that consisted of bilateral knee contusions, left arm contusion, and complaints of pain to her neck, upper back, and chest. The 11-year-old female front right occupant sustained bilateral knee contusions and a right knee abrasion. Both occupants were transported to a local hospital where they were treated and released. The Chevrolet sustained moderate damage and was towed from the crash site. | | | |
| *17. Key Words*<br>Frontal air bags Frontal air bag deployment | | *18. Distribution Statement*<br>General Public | |
| *19. Security Classif. (of this report)*<br>Unclassified | *20. Security Classif. (of this page)*<br>Unclassified | *21. No. of Pages*<br>21 | *22. Price* |

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**SCI CASE NO. – CA04-013**
**SUBJECT VEHICLE – 2003 CHEVROLET AVALANCHE**
**LOCATION - STATE OF TENNESSEE**
**CRASH DATE – FEBRUARY 2004**

## BACKGROUND

This on-site investigation focused on the performance of the Certified Advanced-208 Compliant (CAC) safety system in a 2003 Chevrolet Avalanche **(Figure 1)**. A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard No. 208. The safety system included dual stage frontal air bags, seat track position sensors for the front seats, an occupant detection sensor for the front right seat, and safety belt switch sensors. The frontal air bags deployed during the crash sequence. In addition to the CAC features, the Chevrolet was equipped with seatback mounted side impact air bags for the front seats that did not deploy and an Event Data Recorder that was downloaded (Deployment and Non-Deployment) during the on-site investigative effort. The EDR printout is included as **Attachment A** of this report. The Chevrolet was occupied by an unrestrained 36-year-old female driver and an unrestrained 11-year-old female front right occupant. The Chevrolet was involved in a run-off-road collision where the undercarriage impacted an earth embankment and the front impacted several small diameter trees. The front right area impacted a large diameter tree that deployed the frontal air bags. The driver sustained minor injuries that consisted of bilateral knee contusions, left arm contusion, and complaints of pain to her neck, upper back, and chest. The 11-year-old female front right occupant sustained bilateral knee contusions and a right knee abrasion. Both occupants were transported to a local hospital where they were treated and released. The Chevrolet sustained moderate damage and was towed from the crash site.

**Figure 1. Subject vehicle - 2003 Chevrolet Avalanche.**

This crash was identified from a list of claims provided by an insurance company to the National Highway Traffic Safety Administration (NHTSA) that identified Certified Advanced-208 Compliant vehicles that had been involved in crashes. NHTSA forwarded a list of vehicles to the General Dynamics Special Crash Investigations (SCI) team for follow-up investigation. The Chevrolet Avalanche was located and cooperation was established with the claims representative. The case was assigned to the General Dynamics SCI team on March 20 as an on-site investigative effort. The Chevrolet was inspected on March 25, 2004. The crash site was documented and the in-person driver interview was conducted on March 26.

## SUMMARY

### *Crash Site*

This run-off-road crash occurred during the daylight hours of March 2004. At the time of the crash, the weather was clear with no adverse conditions. The crash occurred off-road of an east/west two-lane, two-way, rural roadway **(Figure 2)**. A left curve for eastbound travel terminated 37.5 m (123.0') west of the point of departure from the travel lane. The Avalanche ascended a positive grade that averaged 1.5 percent. The south roadside consisted of a 0.4-meter (1.3 feet) wide stone/gravel shoulder, a 1.1-meter (3.6 feet) wide by 30.5 cm (12.0") deep ditch, grass, and a tree line. The posted speed limit for the north/south roadway was 72 km/h (45 mph). The scene schematic is included as **(Figure 15)** of this report.

**Figure 2. Eastbound view of the crash site.**

### *Vehicle Data – 2003 Chevrolet Avalanche*

The 2003 Chevrolet Avalanche was identified by the Vehicle Identification Number (VIN): 3GNEC13T03 (production sequence omitted). The odometer reading at the time of the inspection was 33,353 kilometers (20,425 miles). The vehicle was a full-size, four-door pickup truck that was equipped with a 5.3-liter, V8 engine, 4-speed automatic transmission, rear-wheel drive, power-front and rear disc brakes with anti-lock, OEM alloy wheels, power-steering, tilt steering wheel, and power adjustable pedals that were adjusted to a full-rear position in relation to the vehicle. The Chevrolet was configured with Goodyear Wrangler HP All Season tires size, P265/70R17. The manufacturer recommended tire pressure was 241.3 kpa (35.0 psi). The specific tire data was as follows:

| Tire | Measured Pressure | Tread Depth | Restricted | Damage |
|---|---|---|---|---|
| LF | 206.8 kpa (30.0 psi) | 6 mm (8/32) | No | None |
| LR | 165.5 kpa (24.0 psi) | 6 mm (8/32) | No | None |
| RF | 0 kpa | 7 mm (9/32) | No | Deformed/fractured wheel rim bead, tire de-beaded |
| RR | 203.4 kpa (29.5 psi) | 6 mm (7/32) | No | None |

The seating positions in the Chevrolet were configured with leather trimmed front buckets seats with height adjustable head restraints. The front seat head restraints were both adjusted to the full-down positions at the time of the vehicle inspection. The second row was configured with a three-passenger split bench seat (60/40 left side wide) and height adjustable head restraints for the outboard seating positions and an integrated head

restraint for the center position. The outboard head restraints were adjusted to the full-down positions. The rear seat backs folded forward and the back wall of the cab and the backlight were removable to transform the Avalanche into a full-length pickup truck. The rear seat and rear partition were in the upright positions at the time of the crash. The Avalanche was also equipped with the OnStar system which activated during the crash.

### *Crash Sequence*

#### *Pre-Crash*

**Figure 3. Look back view of the curve.**

The unrestrained 36-year-old female driver of the Chevrolet Avalanche was operating the vehicle eastbound on the two-lane roadway. As vehicle exited the left curve (**Figure 3** is a look back view of the curve), she stated to the SCI investigator that a deer ran onto the roadway. The driver steered left to avoid the deer and then overcorrected to the right and departed the roadway. She further noted that she did not recall applying the vehicle's brakes. Based on the EDR Non-Deployment data, the vehicle speed was 85.3 km/h (53.0 mph) at five-seconds prior to Algorithm Enable (AE) for the Non-Deployment event. The vehicle speed over this five-second interval was 80, 71, 61, 39, and 35 km/h (50, 44, 38, 24, and, 22 mph. The EDR data also indicated the driver applied a level of braking at two seconds of AE. The Avalanche departed the right (south) road edge in a tracking mode. Two eroded tire marks were present on the grassy roadside environment. It should be noted that fast food wrappers were present on the floor of the vehicle and drink cups with liquid remained in the center console cup holders.

**Figure 4. Point of road departure.**

**Figure 5. Vehicle's trajectory and struck trees.**

***Crash***

The front undercarriage aspect of the Chevrolet impacted a shallow earth embankment **(Figure 4)** as it traversed the drainage ditch. This event resulted in the EDR recorded Non-Deployment event that indicated the vehicle speed had reduced to 61.2 km/h (38.0 mph) one-second prior to AE with the embankment. The maximum EDR recorded delta-V for this impact was -4.0 km/h (-2.5 mph) at 140 milliseconds from Algorithm Enable (AE). The low delta-V recorded by the EDR was consistent with the minor undercarriage impact from the embankment. The embankment was gouged by this impact.

The Chevrolet continued on a tracking trajectory off-road for approximately 20.5 meters (67.3 feet) where the front of the vehicle impacted four small diameter trees **(Figure 5)**. The trees ranged from 2.5-6.4 cm (1.0-2.5") in diameter and where knocked down and overrode by the vehicle. These impacts were minor and probably resulted in no damage to the bumper of the Avalanche. Additionally, these small diameter tree impacts did not alter the vehicle's trajectory.

The Chevrolet continued forward and impacted a large diameter tree with its front right area. The tree diameter measured 50.8 cm (20.0") at the base and reduced to 25.4 cm (10.0") in diameter at a point 60.1 cm (24.0") above ground level **(Figure 6)**. The direction of force was 12 o'clock and the impact resulted in the Stage One deployment of the driver and front right air bags. The EDR recorded a Deployment file that identified the travel speed at 80.5 km/h (50.0 mph) five-seconds prior to AE and 35.4 km/h (22.0 mph) at one-second prior to AE for this crash event. The brake switch status was in the off-position five-seconds prior and in the on-position from four to two seconds prior to AE. The driver applied a braking force one-second prior to AE at impact with the large diameter tree. The EDR maximum-recorded delta-V for this impact was -26.3 km/h (-16.3 mph) at 167.5 milliseconds from AE. A WinSMASH calculation using the Barrier Equivalent algorithm computed a delta-V for this impact at 14.0 km/h (8.7 mph). The longitudinal and lateral components were -14.0 km/h (-8.7) and 0, respectively. It should be noted that the frontal components were removed from the vehicle prior to the inspection and that the crush profile was documented to a front frame cross member which under stated the true crush profile. The Avalanche crushed to maximum engagement and came to rest against the struck tree. The physical evidence at the crash site did not support a clockwise rotation that is commonly associated with offset right frontal crashes.

**Figure 6. Event 6 impact to large tree.**

***Post-Crash***

The driver stated to the SCI investigator that an OnStar call center representative called the vehicle and asked if the police had been notified. A passerby stopped at the crash site and called for police assistance on his cellular telephone. Police and EMS were

summoned to the crash site; however, it was unknown if the emergency response was triggered by OnStar or the cellular call. The driver and front right occupant sustained minor injuries and were transported by ambulance to a local hospital where they were treated and released. The Chevrolet sustained moderate damage and was towed from the crash site. The vehicle was subsequently transported to a local body shop where it was dismantled and considered a total loss by the insurance company.

### *Vehicle Damage*

#### *Exterior Damage – 2003 Chevrolet Avalanche*

The initial impact with the earth embankment did not produce residual damage to the Chevrolet Avalanche. Dirt and debris were apparently washed from the vehicle at the time of the damage estimate and were not present on the Avalanche at the time of the SCI inspection. The Collision Deformation Classification (CDC) for this impact was 00-UFDU-9.

The frontal area of the Avalanche impacted and overrode four small diameter trees. The vehicle was dismantled prior to the SCI investigation. The front bumper and the hood were missing from the vehicle; therefore the severity of damage from these impacts was unknown. These small diameter trees would have resulted in either minor or no residual damage. The partial CDC's for these impacts were 12-FL99-1, 12-FR99-1, 12-FR99-1, and 12-FL99-1.

The Chevrolet sustained moderate front right damage from the impact with the large diameter tree **(Figure 7)**. Although the frontal components were removed from the vehicle, the right front fender, upper radiator support, and the fan shroud were placed in the bed of the truck and removed for inspection. The leading edge of the right front fender was crushed from the tree impact. Comparison measurements from the left front fender yielded a crush depth of 29.8 cm (11.75") at the top surface of the right front fender and 41.9 cm (16.5") at the mid aspect of the fender, at top bumper level. The aluminum upper radiator support was not crushed. The components that were removed from the vehicle were the bumper, hood, grille, both headlamp assemblies, and the upper radiator support. The large diameter tree impact displaced the entire frontal structure of the Avalanche. Two crush profiles were documented for this impact; one at the level of the front frame rails and crossmember, and the second at the level of the lower radiator support. The width of the frame rails was 119.4 cm (47.0"), which served as the Field L. The crush profile at the frame and crossmember level was as follows: C1 = 0, C2 = 2.5 cm (1.0"), C3 = 3.8 cm (1.5"), C4 = 5.1 cm (2.0"), C5 = 7.6 cm (3.0"), C6 = 7.1 cm (2.8"). The six crush measurements were documented at the level of the lower radiator support using a width of 143.0 cm (56.3") and were as follows: C1 = 21.8 cm (8.6"), C2 = 21.5 cm (8.5"), C3 = 0, C4 = 6.3 cm (2.5"), C5 = 10.6 cm (4.2"), C6 = 45.0 (17.7").

**Figure 7. Overall view of the dismantled frontal damage.**

The CDC for this impact was estimated at 12-FREW-2 based on the diameter of the tree and maximum crush at the leading edge of the right front fender.

The Chevrolet's windshield was fractured from contact with the hood edge. The remainder of the glazing remained intact and all four doors remained closed during the crash and operational post-crash.

***Interior Damage – 2003 Chevrolet Avalanche***

The 2003 Chevrolet Avalanche sustained minor interior damage as a result of occupant contact. There was no intrusion of the passenger compartment. At impact with the large diameter tree, the frontal air bags deployed. The driver's left arm was deflected by the deploying air bag and contacted the lower aspect of the left A-pillar. This contact was evidence by a subtle tissue transfer on the trim of the A-pillar **(Figure 8)** that was located 5.7-8.6 cm (2.25-3.375") above the top surface of the instrument panel**.** The driver initiated a forward trajectory that resulted in knee contacts to the knee bolster and a head contact to the left aspect of the steering wheel rim. Her head loaded through the deployed air bag which scuffed and deformed the left side of the steering wheel rim to a depth of 0.6 cm (0.25"). In addition to the rim deformation, the steering wheel mounting flange was deformed which resulted in a forward deflection of the left side of the steering wheel rim. The deflection was measured at 2.2 cm (0.875"). The driver's left knee scuffed the mid aspect of the rigid bolster panel below the steering column. The scuff was located 45.7-48.3 cm (18.0-19.0") left of the centerline and 44.4-46.4 cm (17.5-18.25") below the upper instrument panel. The right knee scuff was located at the right edge of the bolster 19.1-22.9 cm (7.5-9.0") left of center and 41.9-46.4 cm (16.5-18.25") below the referenced instrument panel.

**Figure 8. Driver's left arm contact to the left upper A-pillar.**

The front right occupant initiated a forward trajectory in response to the frontal impact force. Her right knee contacted the lower right instrument panel, outboard of the glove box door. A circular tissue transfer was noted to the plastic panel located 75.6-78.7 cm (29.75-31.0") right of the vehicle's centerline and 28.5-31.4 cm (11.25-12.375") below the upper instrument panel. **Figures 9 and 10** are views of the occupant's knee contacts to the knee bolster and the lower right instrument panel.

The driver and front right passenger loaded the deployed Stage One air bags during the crash. There was no contact evidence or damage to the air bag membrane.

**Figure 9. Driver's knee contacts to the knee bolster.**

**Figure 10. Passenger's right knee contact to the lower right instrument**

***Certified Advanced-208 Compliant Safety System – 2003 Chevrolet Avalanche***

The 2003 Chevrolet Avalanche was equipped with a Certified Advanced-208 Compliant (CAC) frontal safety system. A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Safety Standard No. 208. The system consisted of dual stage frontal air bags, seat track positioning sensors for the front seats, an occupant presence sensor for the front right seat, and safety belt buckle switch sensors to monitor belt usage. A Sensing and Diagnostic Module (SDM) controlled the system. The SDM measures and predicts crash severity and monitors seat track position, belt status, and occupant presence to deploy the appropriate safety system. In the subject crash, the SDM commanded a Stage One deployment of the driver and front right passenger air bags at 25.0 milliseconds from AE. In addition to the SDM, two satellite crash sensors were mounted to the lower radiator support panel. The sensors were not damaged and were identified by the following nomenclature:

Left Sensor:
AD7506V0B5QD
Part No. 15057506

Right Sensor:
AD7506VH5A2R
Part No. 15057506

The driver's air bag was located in the center of the steering wheel hub **(Figure 11).** Two symmetrical I-configuration cover flaps concealed the air bag. Both cover flaps measured 11.7 cm (4.625") in height at the center tear seam. The left flap measured and 7.0 cm (2.75") in width at the top and 5.3 cm (2.1") in width at the bottom. The right cover flap measured 7.3 cm (2.9") in width at the top and 5.1 cm (2.0") in width at the bottom. The air bag membrane was 69.9 cm (27.5") in diameter in its deflated state and was vented by two 2.5 cm (1.0") diameter vent ports that were located on the rear aspect of the air bag at the 11

**Figure 11. Deployed driver's frontal air bag.**

and 1 o'clock positions. The driver's air bag was tethered by two 13.9 cm (5.5") wide band tethers at the 12 and 6 o'clock positions. The maximum excursion of the air bag from the face of the module cover was measured at 25.4 cm (10.0") at the tether locations. There were no occupant contact points present on the air bag membrane; however, dirt transfers were present on the bag face at the 4 and 8 o'clock positions from post-crash handling of the air bag. The driver bag was identified by the following nomenclature printed to the face of the air bag:

312273 420d

A label was affixed to the 3 o'clock sector of the air bag at the inflator. The bar coded label read as follows:

GMTG DRIVER
16872189

The front right passenger air bag was a mid-mount design in the right instrument panel **(Figure 12)**. The air bag was concealed by a single cover flap that measured 14.3 cm (5.6") in height and 38.9 cm (15.3") in width. The flap opened in an upward direction with a top mounted horizontal hinge point. A bar-coded label affixed to the left inside surface of the flap read as follows: AL781AZ8223Y0126

**Figure 12. Deployed front right air bag.**

The front right air bag membrane measured 46.9 cm (18.5") in height and 53.3 cm (21.0") in width and was tethered by a single wide band tether that was approximately 29.2 cm (11.5") wide, located 16.5 cm (6.5") below the top apex of the air bag. Two vent ports that measured 2.8 cm (1.1") were located at the 3 and 9 o'clock positions of the side panels vented the air bag. No occupant contact or damage was noted to the front right air bag.

***Event Data Recorder – 2003 Chevrolet Avalanche***

The 2003 Chevrolet Avalanche was equipped with an Event Data Recorder (EDR). The EDR was downloaded during the SCI inspection and the printout is included as **Attachment A** of this report. The SDM was downloaded through the diagnostic connector (J1962) that was located under the driver's side knee bolster using the Vetronix Crash Data Retrieval tool. The OEM battery cables were intact and were connected to a charged vehicle battery that provided power for the download process.

The downloaded data consisted of two events, a Non-Deployment and Deployment event. The Non-Deployment event was recorded as result of the impact with the embankment. The data indicated the vehicle speed was 85.3 km/h (53.0 mph) five-seconds prior to AE and that the vehicle had slowed to 61.2 km/h (38.0 mph) one-second prior to the impact with the embankment. The EDR also indicated that the driver's safety belt was unbuckled and the brake switch status was in the off-position from five to three seconds prior to AE and in the on-position from two to one-second prior to AE. The maximum-

recorded delta-V for this impact was -4.0 km/h (-2.5 mph) at a 140 milliseconds from AE.

The Deployment event was a result of the impact with the large diameter tree. The EDR recorded a Stage One deployment of the frontal air bag system at 25.0 milliseconds after AE. The travel speed was 80.5 km/h (50.0 mph) at the five-second interval and 35.4 km/h (22.0 mph) one-second prior AE with the tree impact. The brake switch status was in the off-position at five-seconds and in the on-position from four-to-two seconds prior to impact. The maximum-recorded delta-V for this impact was -26.3 km/h (-16.3 mph) at 167.5 milliseconds from AE.

***Side Impact Air Bags – 2003 Chevrolet Avalanche***

The 2003 Chevrolet Avalanche was equipped with seatback mounted side impact air bags for the front outboard seat positions. The side impact air bags did not deploy in this crash.

***Manual Restraint Systems – 2003 Chevrolet Avalanche***

The 2003 Chevrolet Avalanche was equipped with integrated manual 3-point lap and shoulder safety belts for front outboard seating positions **(Figures 13 and 14)**. The rear outboard positions were equipped with manual 3-point lap and shoulder safety belts. The rear center safety belt was configured with a 2-point manual lap belt. The driver's safety belt was configured with a sliding latch plate, and an Emergency Locking Retractor (ELR). The front right safety belt was configured with a sliding latch plate and a switchable ELR/Automatic Locking Retractor (ALR). Historical usage evidence was noted to the front latch plates, which consisted of minor scratches. There was no loading evidence to verify restraint usage in this multiple event crash. The rear safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractor's (ALR). Historical usage evidence was noted to the rear outboard latch plates, which consisted of minor scratches; however, the rear center latch plated showed no evidence of historical usage.

**Figure 13. Driver's safety belt.**

**Figure 14. Front right safety belt.**

***Occupant Demographics – 2003 Chevrolet Avalanche***

***Driver***

| | |
|---|---|
| Age/Sex: | 35-year-old/Female |
| Height: | 155.1 cm (61.0”) |
| Weight: | 82.0 kgs (180.0 lbs) |
| Seat Track Position: | Probable mid track (seat was moved prior to SCI investigation) |
| Manual Restraint Use: | None used |
| Usage Source: | Vehicle inspection |
| Eyewear: | None |
| Type of Medical Treatment: | Transported to a local hospital where she was treated and released. |

***Driver Injuries***

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|---|
| Bilateral knee contusions | Minor (890402.1,3) | Knee bolster |
| Left arm contusion (NFS) | Minor (790402.1,2) | Fling injury into left upper A-pillar |
| Cervical strain | Minor (640278.1,6) | Induced injury from steering wheel rim loading |
| Thoracic strain | Minor (640478.1,6) | Induced injury from steering wheel rim loading |

*Source of Injury Data - Emergency room records and driver interview*

***Driver Kinematics***

The 35-year-old female driver of the 2003 Chevrolet Avalanche was seated in a presumed upright posture with the seat track adjusted to a mid track position. At the time of the SCI inspection, the power seat track was found adjusted to a rear track position. The driver stated to the SCI investigator that at 155.1 cm (61.0”) in height, she moved the seat as far back as possible. Additionally, she had the adjustable pedals set to the full rear position with respect to the vehicle. The driver was not restrained by the integrated manual 3-point lap and shoulder belt system. There was no loading evidence to verify restraint usage in this multiple event crash and her contact with the steering wheel rim and the knee bolster were consisted of an unrestrained driver. The EDR data verified the investigators determination of restraint usage by listing the driver belt status as “unbuckled”.

At impact with the embankment, the driver initiated a forward and downward trajectory due to the impact involving the undercarriage of the vehicle. The Chevrolet continued forward in a tracking mode and impacted and overrode four small diameter trees with the frontal area. These impacts were minor in severity and did not displace the driver or alter the vehicle trajectory.

The Avalanche subsequently impacted a large diameter tree with its front right area. The 12 o’clock direction of force impact resulted in a Stage One deployment of the frontal air

bag system at an EDR recorded 25 ms following AE. The deploying driver's frontal air bag expanded against the driver's left forearm that resulted in a fling contact to the left upper A-pillar. A scuffmark to the A-pillar evidenced the contact that resulted in a soft tissue contusion of the forearm.

The driver initiated a forward trajectory in response to the frontal impact force. Her knees loaded the rigid knee bolster panel that resulted in bilateral knee contusions. Scuffmarks evidence the contact points. The knee contacts arrested the forward motion of the driver's pelvic region and induced a forward and downward trajectory of her chest and head. The right aspect of her head loaded through the deployed air bag and impacted the left aspect of the steering wheel rim, deforming the wheel rim 0.6 cm (0.25") forward. Her chest loaded the deployed air bag and compressed the inflated bag against the steering assembly. The combination of the head and chest loading force against the wheel rim deflected the rim forward at the left aspect. This deflection was attributed to bending of the steering wheel rim-mounting flange. The steering wheel rim loading resulted in strain of the cervical and thoracic spine.

***Medical Treatment***

The driver was transported by ambulance to a local hospital where she was evaluated and treated for her injures. Diagnostic X-rays of the cervical spine, chest, and both knees were performed with negative results. She was released from the emergency room with her daughter, the front right passenger at 1 hour and 15 minutes following her arrival to the hospital.

***Front Right Occupant***

| | |
|---|---|
| Age/Sex: | 11-year-old/Female |
| Height: | 150.0 cm (59.0") |
| Weight: | 66.0 kgs (146.0 lbs) |
| Seat Track Position: | Rear track [(21.6 cm (8.5") of track travel] |
| Manual Restraint Use: | None Used |
| Usage Source: | Vehicle inspection |
| Eyewear: | None |
| Type of Medical Treatment: | Transported to a local hospital where she was treated and released. |

***Front Right Occupant Injuries***

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|---|
| Left knee contusion | Minor (890402.1,2) | Glove box door |
| Right knee contusion | Minor (890402.1,1) | Lower right instrument panel |
| Right knee abrasion | Minor (890202.1,1) | Lower right instrument panel |

*Source of Injury Data – Emergency room records*

### *Front Right Occupant Kinematics*

The 11-year-old female front right occupant of the 2003 Chevrolet Avalanche was seated in a presumed upright posture with the seat track adjusted to a rear track position. The seat track was adjusted 2.5 cm (1.0") forward of the full rear track position. The seat back was set to a reclined angle of 18 degrees and the seat cushion angle measured 11 degrees. In this adjusted position, the horizontal distance between the leading edge of the mid mount front right air bag module cover flap and the seat back was 83.2 cm (32.75"), measured at a point that was 30.5 cm (12.0") above the seat bight. The child passenger was not restrained by the integrated manual 3-point lap and shoulder belt system. The non-use of the integrated safety belt system was determined from the lack of loading evidence on the webbing and hardware components. In addition, occupant contact evidence was consistent with an unrestrained occupant.

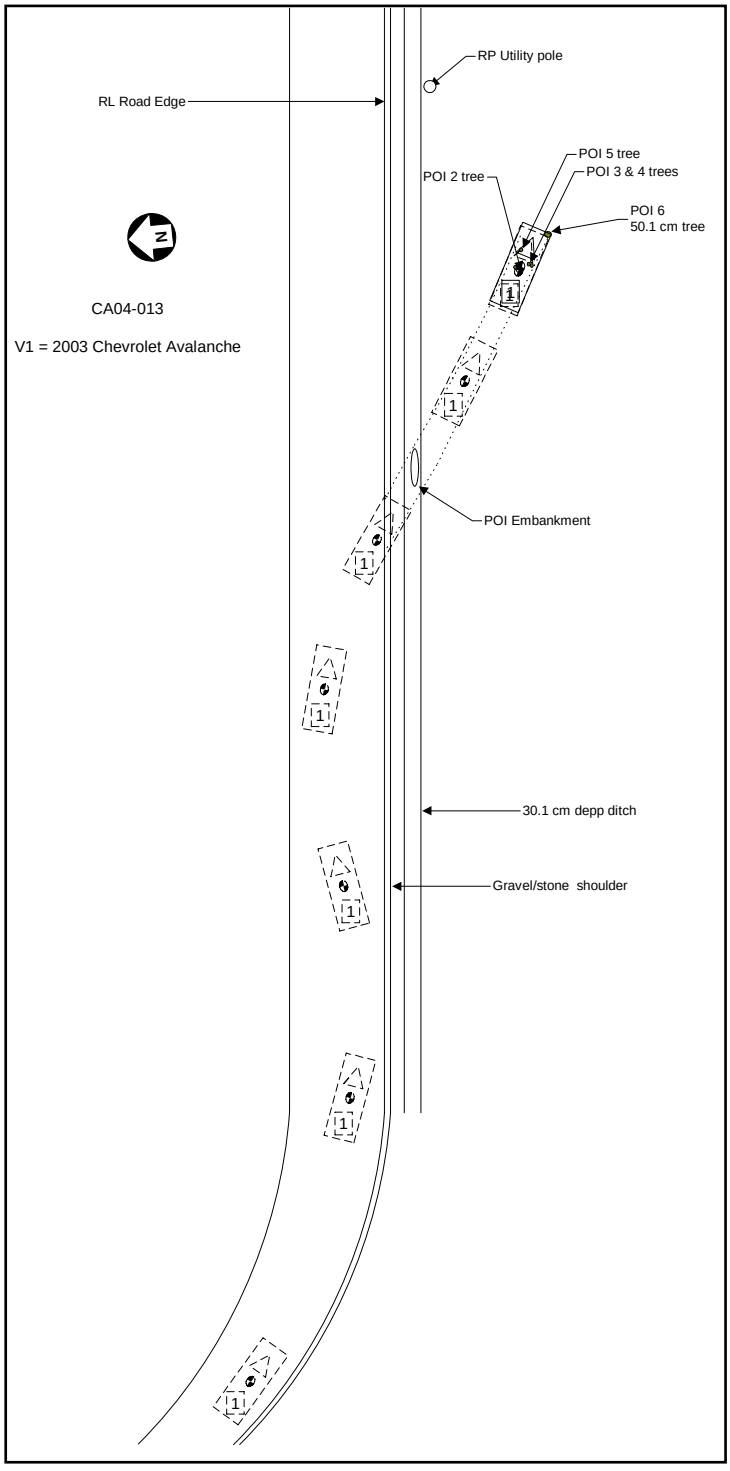
At impact with the embankment, the child passenger was displaced forward and vertically downward, loading the seat cushion. The Chevrolet continued forward off-road and impacted and overrode four small diameter trees with the frontal area. These impacts were minor in severity and did not further displace the passenger.

At impact with the large diameter tree, the frontal air bag system deployed at 25 ms following AE. The child passenger initiated a forward trajectory and loaded the deployed air bag which prevented her from contact with the upper instrument panel and windshield. Her knees contacted the glove box door and the lower right instrument panel which resulted in the bilateral knee contusions and the right knee abrasion. A 2.8 cm (1.1") diameter tissue transfer evidenced the right knee contact. There was no loading evidence of the glove box door. The child probably rebounded into the seat back where she came to rest. She exited the vehicle unassisted and waited at the scene for emergency personnel to arrive.

### *Medical Treatment*

The front right child passenger was transported by ambulance to a local hospital where she was examined and treated for her injuries. She was discharged 1 hour and 15 minutes following her arrival to the hospital emergency room.

***Figure 15. Scene schematic***



***Attachment A: Chevrolet's EDR Printout***

## CDR File Information

| | |
|---|---|
| Vehicle Identification Number | 3GNEC13T03Gxxxxxx |
| Investigator | |
| Case Number | |
| Investigation Date | |
| Crash Date | |
| Filename | |
| Saved on | Thursday, March 25 2004 at 04:56:15 PM |
| Data check information | DCD7B552 |
| Collected with CDR version | Crash Data Retrieval Tool 2.10 |
| Collecting program verification number | B6B4FDF8 |
| Reported with CDR version | Crash Data Retrieval Tool 2.21 |
| Reporting program verification number | 6B1D6F0F |
| Interface used to collected data | Block number: 00<br>Interface version: 35<br>Date: 01-02-03<br>Checksum: 6200 |
| Event(s) recovered | Deployment<br>Non-Deployment |

## SDM Data Limitations

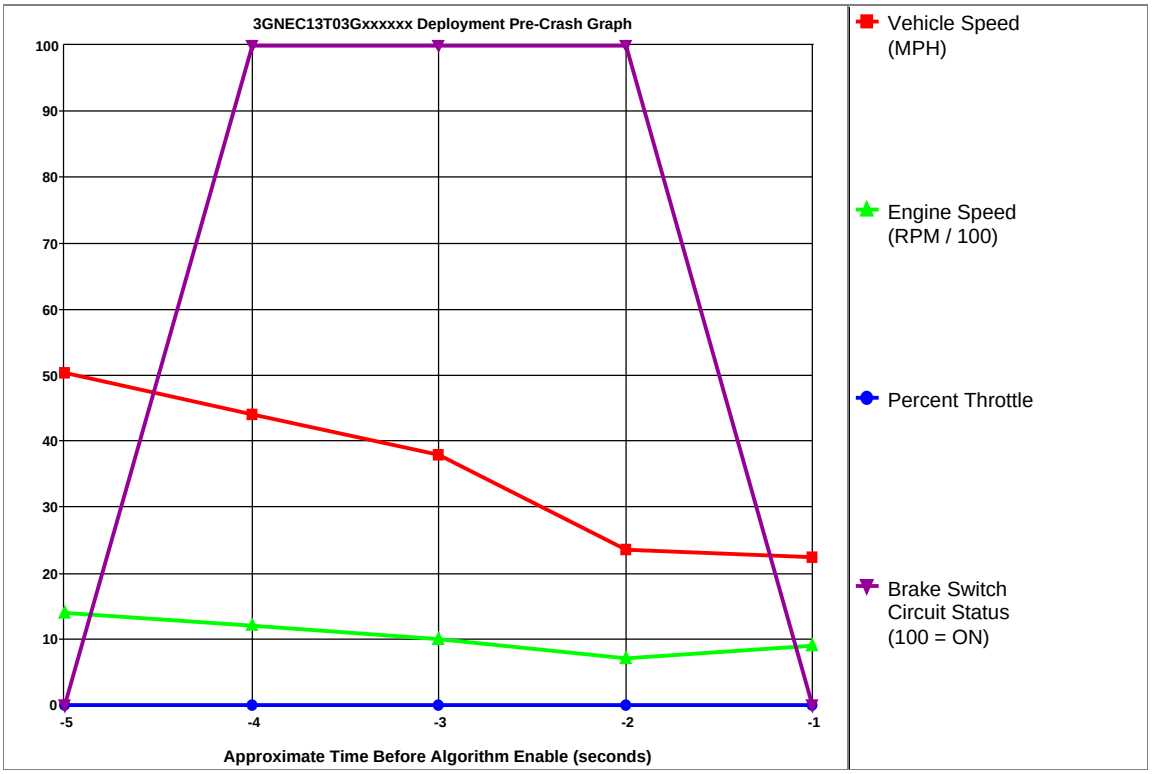
SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store 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.

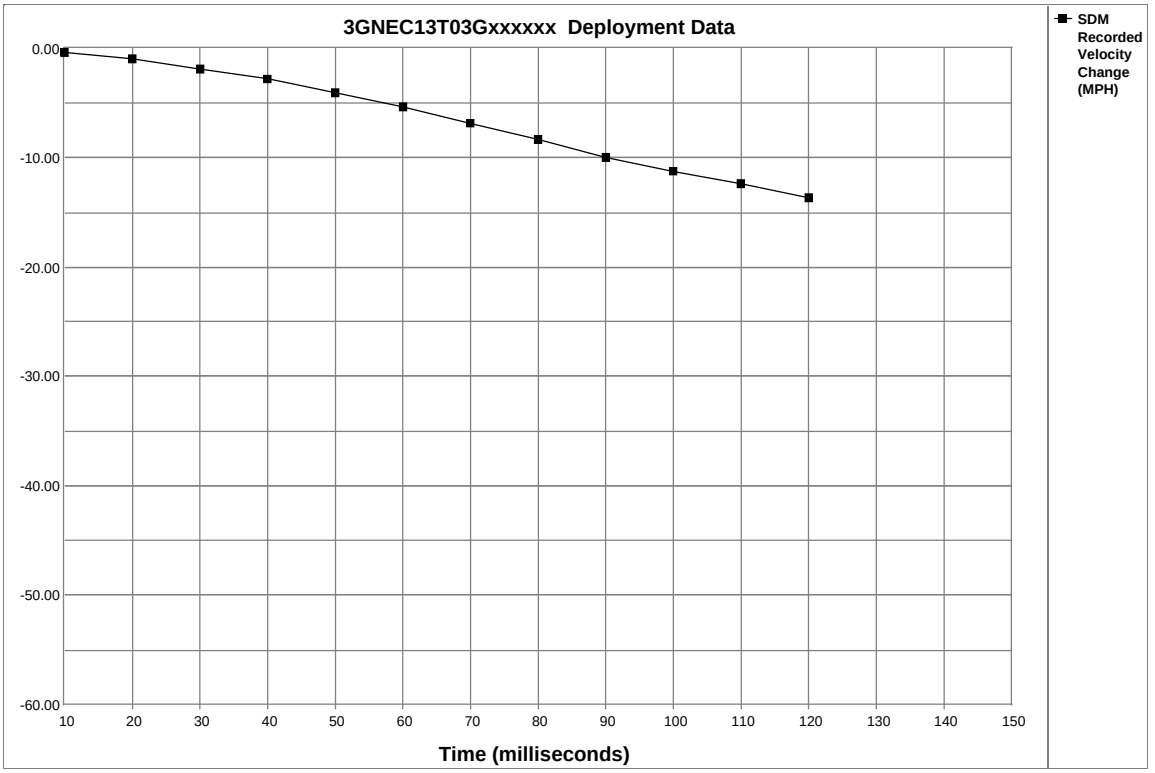
SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the Class 2 data link, to the SDM.
-Brake Switch Circuit Status 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 | UNBUCKLED |
| Ignition Cycles At Deployment | 2335 |
| Ignition Cycles At Investigation | 2350 |
| Maximum SDM Recorded Velocity Change (MPH) | -16.30 |
| Algorithm Enable to Maximum SDM Recorded Velocity Change (msec) | 167.5 |
| Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec) | 25 |
| 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) | 25 |
| Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec) | N/A |
| Time Between Non-Deployment And Deployment Events (sec) | 1.8 |
| Frontal Deployment Level Event Counter | 1 |
| Event Recording Complete | Yes |
| Multiple Events Associated With This Record | Yes |
| One Or More Associated Events Not Recorded | No |



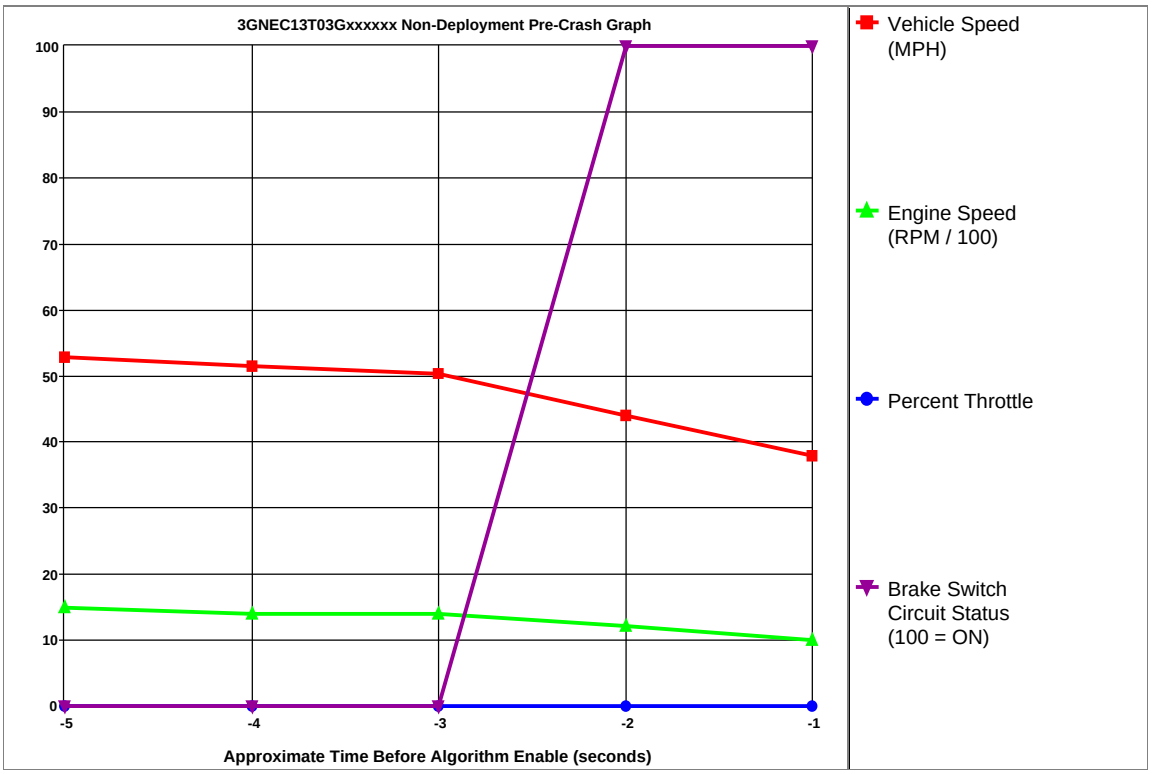

| Seconds Before AE | Vehicle Speed (MPH) | Engine Speed (RPM) | Percent Throttle | Brake Switch Circuit Status |
|---|---|---|---|---|
| -5 | 50 | 1408 | 0 | OFF |
| -4 | 44 | 1216 | 0 | ON |
| -3 | 38 | 960 | 0 | ON |
| -2 | 24 | 704 | 0 | ON |
| -1 | 22 | 896 | 0 | OFF |



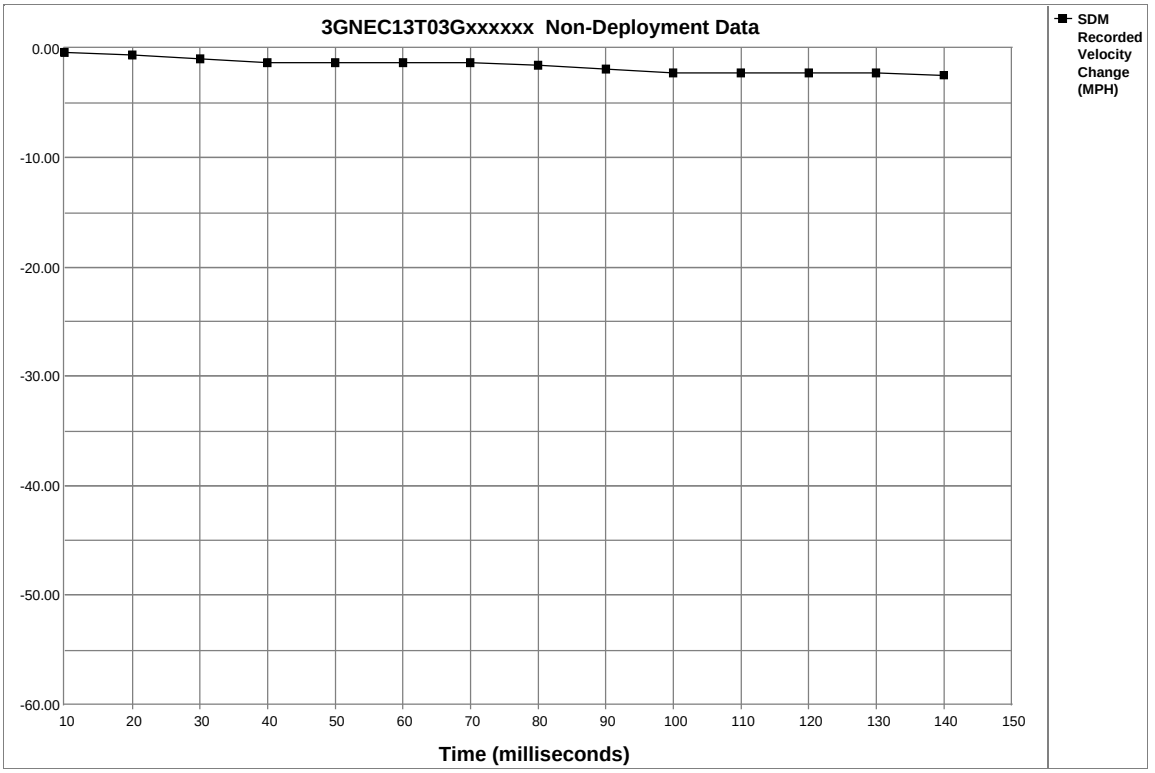

| Time (milliseconds) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recorded Velocity Change (MPH) | -0.31 | -0.93 | -1.86 | -2.79 | -4.03 | -5.27 | -6.82 | -8.37 | -9.92 | -11.16 | -12.40 | -13.64 | N/A | N/A | N/A |

## System Status At Non-Deployment

| | |
|---|---|
| SIR Warning Lamp Status | OFF |
| Driver's Belt Switch Circuit Status | UNBUCKLED |
| Ignition Cycles At Non-Deployment | 2335 |
| Ignition Cycles At Investigation | 2350 |
| Maximum SDM Recorded Velocity Change (MPH) | -2.56 |
| Algorithm Enable to Maximum SDM Recorded Velocity Change (msec) | 140 |
| 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 | 53 | 1472 | 0 | OFF |
| -4 | 52 | 1408 | 0 | OFF |
| -3 | 50 | 1408 | 0 | OFF |
| -2 | 44 | 1216 | 0 | ON |
| -1 | 38 | 960 | 0 | ON |




| Time (milliseconds) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recorded Velocity Change (MPH) | -0.31 | -0.62 | -0.93 | -1.24 | -1.24 | -1.24 | -1.24 | -1.55 | -1.86 | -2.17 | -2.17 | -2.17 | -2.17 | -2.48 | 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  F0 21 F7 3C B0 F8
$02  F1 F1 3C 3C A8 00
$03  41 53 32 32 34 30
$04  56 31 50 46 48 31
$05  30 32 4B 34 35 33
$06  15 05 78 14 00 00
$07  32 02 31 56 00 00
$08  41 44 75 06 56 22
$09  41 30 42 35 51 44
$0A  41 44 75 06 56 22
$0B  41 48 35 41 32 52
$0C  41 55 75 08 58 22
$0D  24 4A 34 30 51 44
$0E  41 55 75 08 56 22
$0F  35 30 30 52 52 57
$10  FE DA C0 00 00 00
$11  81 81 81 80 7F 80
$12  96 00 00 3B 3D 00
$13  FF 02 00 00 00 00
$14  1D 1D 05 05 64 40
$15  FA FA FA FA FA FA
$16  FA FA FA FA FA FA
$17  FA FA 00 00 00 00
$18  00 3F 55 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  92 FE 00 00 FF FF
$21  FF FF FF FF FF FF
$22  FF FF FF FF FF FF
$23  FF FF FF FF FF FF
$24  00 00 84 00 38 10
$25  08 00 00 00 00 00
$26  01 02 03 04 04 04
$27  04 05 06 07 07 07
$28  07 08 00 0E FE DC
$29  80 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  BA FD 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 03 15 0A 03
$35  00 03 15 0A 03 00
$36  00 00 00 00 00 00
$37  00 00 00 03 48 5C
$38  43 0B 6F 39 ED 00
$39  03 00 00 00 00 00
$3A  01 03 06 09 0D 11
$3B  16 1B 20 24 28 2C
$3C  00 00 00 0C FE DC
$3D  80 A5 00 00 00 00
$40  3D 47 51 53 55 00
$41  C0 00 00 00 00 00
$42  00 00 0F 13 16 16
$43  17 00 7D 80 00 00
```

```
$44  24 26 3D 47 51 00
$45  70 00 00 00 00 00
$46  00 00 0E 0B 0F 13
$47  16 00 7D 80 00 00
$48  FF FF FF FF FF FF
$49  FF FF FF FF FF FF
$4A  FF FF FF FF FF FF
$4B  FF FF FF FF 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
```