

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

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**GENERAL DYNAMICS ON-SITE AIR BAG NON-DEPLOYMENT
INVESTIGATION**

GENERAL DYNAMICS CASE NO. – CA03-057

SUBJECT VEHICLE – 1995 PONTIAC GRAND PRIX

LOCATION - STATE OF VIRGINIA

CRASH DATE – OCTOBER 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

Because each crash is a unique sequence of events, generalized conclusions cannot be made concerning the crashworthiness performance of the involved vehicle(s) or their safety systems.

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| <p>16. <i>Abstract</i> This on-site investigation focused on the non-deployed status of the frontal air bags in a 1995 Pontiac Grand Prix. The Pontiac was equipped with frontal air bags for the driver and front right passenger positions. The Pontiac was also equipped with an Event Data Recorder (EDR) that was downloaded (Non-deployment) during the on-site SCI investigation. The vehicle was occupied by a 21-year old male driver and a 37-year old male front right passenger. The driver was operating the vehicle southbound on a three-lane roadway, entering a left curve. The driver lost directional control of the vehicle as he attempted to negotiate the curve and initiated a counterclockwise (CCW) yaw. The vehicle subsequently departed the east road edge where it impacted and mounted an earth embankment which redirected the Pontiac in a clockwise direction. The Pontiac continued off-road and impacted a delineator post and seven small diameter trees with its frontal area. The center frontal area of the Grand Prix impacted a large diameter tree that resulted in severe frontal damage. The frontal air bags did not deploy as a result of this impact. The unrestrained driver of the Pontiac sustained police reported visible injury and was transported to a local trauma center. The unrestrained front right passenger sustained severe head injuries as a result of the crash and expired following arrival to a local medical facility.</p> | | | |
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GENERAL DYNAMICS ON-SITE AIR BAG NON-DEPLOYMENT INVESTIGATION
GENERAL DYNAMICS CASE NO. – CA03-057
SUBJECT VEHICLE – 1995 PONTIAC GRAND PRIX
LOCATION - STATE OF VIRGINIA
CRASH DATE – OCTOBER 2003

BACKGROUND

This on-site investigation focused on the non-deployed status of the frontal air bags in a 1995 Pontiac Grand Prix. The Pontiac was equipped with frontal air bags for the driver and front right passenger positions. The Pontiac was also equipped with an Event Data Recorder (EDR) that was downloaded (Deployment and Non-Deployment events) during the on-site SCI investigation. The EDR printout is included as **Attachment A** of this report. The vehicle was occupied by a 21-year old male driver and a 37-year old male front right passenger. The driver was operating the vehicle southbound on a three-lane roadway, entering a left curve. The driver lost directional control of the vehicle as he attempted to negotiate the curve and initiated a counterclockwise (CCW) yaw. The vehicle subsequently departed the east road edge where it impacted and



Figure 1. Frontal damage to the 1995 Pontiac Grand Prix.

mounted an earth embankment which redirected the Pontiac in a clockwise direction. The Pontiac continued off-road and impacted a delineator post and seven small diameter trees with its frontal area. The center frontal area of the Grand Prix impacted a large diameter tree that resulted in severe frontal damage (**Figure 1**). The frontal air bags did not deploy as a result of this impact. The unrestrained driver of the Pontiac sustained multiple minor to serious severity injuries and was transported to a local hospital where he was admitted for five days. The unrestrained front right passenger sustained multiple minor to critical severity injuries as a result of the crash and expired prior to arriving at a local hospital.

This October crash was reported to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) by the investigating police officer. Due to the non-deployment status of the frontal air bag system and the fatal injuries sustained by the front right passenger, the crash was assigned to the General Dynamics Special Crash Investigations team as an on-site investigative effort on October 9, 2003. Cooperation was established with the investigating officer and an on-site investigation occurred on October 22, 2003.

SUMMARY

Crash Site

This single vehicle crash occurred during the nighttime hours of October 2003. At the time of the crash, the weather was clear with no adverse conditions. The crash occurred off-road on the east road edge of a six-lane north/south roadway. The north/south asphalt roadway consisted of three lanes, one in each direction and a southbound right turn lane. A three-lane east/westbound roadway that terminated at the apex of the curve intersected the north/south roadway in a T-type intersection. The north leg of the north/south roadway was divided by a raised concrete median

and the south leg was divided by a double yellow centerline. The east road edge consisted of an earthen embankment that transitioned to a level area that was scattered with numerous small diameter trees, shrubs, and a rotted tree trunk. The posted speed limit for north/south roadway was 56 km/h (35 mph). **Figure 2** is an overall view of the crash site. The scene schematic is included as **Figure 14** of this report.



Figure 2. Overall southbound view of the crash site.

Vehicle Data – 1995 Grand Prix

The 1995 Grand Prix was a two-door coupe that was identified by the Vehicle Identification Number (VIN): 1G2WJ12M3S (production sequence omitted). The odometer reading was 200,031 km (124,297) at the time of the inspection. The driver had recently purchased the Pontiac and began to operate the vehicle without proper state registration approximately six days prior to the crash. The service and repair history of the Pontiac was unknown. The vehicle was equipped with a 3.1-liter, V6 engine, 4-speed automatic transmission, power-front and rear disc brakes with anti-lock, OEM alloy wheels, power-steering, and a tilt steering wheel. The front tires of the Pontiac were Michelin Symmetry, size P225/60R16. The maximum pressure for these tires was 241.3 kpa (35.0 psi). The left rear tire was a Futura 875; size P225/60R16 with a maximum pressure of 303.4 kpa (44.0 psi). The right rear tire was a Uniroyal Tiger Paw; size P225/60R16 with a maximum pressure of 241.3 kpa (35.0 psi). The manufacture recommended tire pressure for this vehicle was 206.8 kpa (30.0 psi). The specific tire data was as follows:

| Tire | Measured Pressure | Tread Depth | Restricted | Damage |
|------|----------------------|---------------|------------|----------------------|
| LF | 213.7 kpa (31.0 psi) | 7.0 mm (9/32) | No | None |
| LR | 182.7 kpa (26.5 psi) | 6.0 mm (8/32) | No | None |
| RF | 0 kpa (0 psi) | 7.0 mm (9/32) | Yes | Debris in outer bead |
| RR | 206.8 kpa (30.0 psi) | 6.0 mm (8/32) | No | None |

The interior of the Pontiac was configured with front bucket seats with height adjustable head restraints. The head restraints were removed by rescue personnel; therefore the adjustment positions at the time of the crash were unknown. The second row was configured with a bench seat with integrated head restraints for the outboard seating positions

Crash Sequence

Pre-Crash

The 21-year-old male driver of the Pontiac was operating the vehicle southbound (**Figure 3**) on the three-lane roadway, negotiating the left curve on approach to the “T” intersection. The driver lost directional control of the vehicle as he attempted to negotiate the curve. The Pontiac began a counterclockwise (CCW) rotation across the south and northbound travel lanes. A centrifugal (yaw) right front tire mark of the Pontiac was found on the roadway and measured approximately 56.0 m (184.0’) in length. A right rear tire mark was also present on the roadway and measured approximately 51.8 m (170.0’) in length. The police reported pre-impact speed (based on critical curve yaw marks) was 121 km/h (75 mph). The EDR in this vehicle was not capable of recording pre-crash data.



Figure 3. Pontiac's southbound approach to the crash site.

Crash

As the Pontiac departed the east road edge, the front right undercarriage area impacted and overrode an embankment. This impact negated the CCW yaw and redirected the Grand Prix in a clockwise direction, returning the vehicle to a tracking attitude as it continued in a southerly direction. The front left bumper area of the Pontiac impacted and overrode a small diameter tree cluster. As the Pontiac continued forward, the front right area impacted and deflected a delineator post. The Pontiac continued forward for a distance of 8.5 m (28.0’) and impacted a series of small diameter trees and a rotted 17.8 cm (7.0”) diameter tree trunk (**Figure 4**). The Pontiac overrode these trees and deflected the stump at ground level. This series of impacts did not alter the Pontiac’s southerly trajectory or tracking trajectory. It should be noted that all tree impacts involved impact forces that were within the 12 o’clock sector.



Figure 4. Impacts with the embankment and numerous small diameter trees.



Figure 5. Struck 48.3 cm (19.0”) diameter tree.

The center front area of the Pontiac impacted a 48.3 cm (19.0”) diameter tree (**Figure 5**) that was located 4.3 m (14.0’) outboard of the east road edge. A 7.6 cm (3.0”) diameter tree was growing

adjacent to this larger tree and was struck by the Pontiac; however, this sequence was considered a single event. The resultant direction of force for this tree impact was 12 o'clock. The damage and trajectory algorithm of the WinSMASH model was utilized to compute an impact speed of 73.9 km/h (45.9 mph) for the Pontiac. The vehicle crushed to a maximum depth of 99.0 cm (38.9"). The WinSMASH damage output delta-V was calculated at 65.0 km/h (40.4 mph) with a longitudinal component of -65.0 km/h (-40.4 mph) and lateral component of 0 km/h. The frontal air bags did not deploy during this crash. The EDR Deployment data indicated that the time between Algorithm Enable (AE) to deployment command criteria met was 162.5 milliseconds and the maximum-recorded delta V was -17.9 km/h (-11.1 mph) at 300 milliseconds from Algorithm Enable (AE).

Post-Crash

The driver and front right passenger remained in the vehicle post-crash and were observed by the investigating officer. The driver came to rest slumped against the center instrument panel. His head impacted and penetrated the windshield and at rest, his head remained engaged against the windshield. Rescue personnel cut the laminated windshield to remove the driver from the Pontiac. The responding fire fighters cut all six pillars and removed the roof from the vehicle. The driver was removed from the Pontiac and placed on a backboard. He was transported by ambulance to a local hospital where he was admitted for five days and released.

The front right passenger came to rest slumped against the right instrument panel with his head resting against the windshield. He bled profusely from the head onto the upper instrument panel and floor of the vehicle. Fire fighters removed the front right door to facilitate the removal of the passenger from the vehicle. He was transported by ambulance to a local hospital where he was pronounced deceased. The vehicle sustained severe damage and was towed from the scene.

Vehicle Damage

Exterior Damage – 1995 Pontiac Grand Prix

The 1995 Pontiac Grand Prix sustained severe frontal damage (**Figure 6**) as a result of the primary impact with the 48.3 cm (19.0") diameter tree. Maximum crush was 99.0 cm (38.9") and was located on the bumper beam at the location of C3. The direct contact damage was 43.2 cm (17.0") in width and began 11.4 cm (4.5") inboard of the right hood crease and extended left. The impact deformed the entire frontal width of the Grand Prix, bending the bumper beam to a U-configuration. The combined direct and induced damage width was 74.9 cm (29.5") and extended from corner-to-corner on the bumper beam. The left wheelbase was reduced in length by 7.1 cm (2.8") and the right wheelbase was reduced by 9.4 cm (3.7"). A crush profile (**Figure 7**) was documented at the level of the bumper beam and was as follows: C1 = 31.0 cm (12.2"), C2 = 86.0 cm (33.8"), C3 = 99.0 cm (38.9"), C4 = 84.0 cm (33.1"), C5 = 59.0 cm (23.2"), C6 = 43.0 cm (16.9"). The Collision Deformation Classification (CDC) for this primary impact was 12-FCEW-4.



Figure 6. Frontal damage from the large diameter tree.



Figure 7. Overhead view of the crush profile.

Prior to the primary tree impact, the Pontiac impacted an embankment, a series of small diameter trees, a delineator post, and a rotted tree trunk. The direct contact damage for these impacts was masked by the primary tree impact. CDC's were generated for these impacts and are documented in the following table:

Table 2. Collision Deformation Classifications

| Event No. | CDC | Object Struck |
|------------------|------------|--|
| 1 | 00-UFZW-1 | Earth embankment |
| 2 | 12-FLLN-1 | Small diameter tree Cluster |
| 3 | 12-FRLN-1 | Delineator Post |
| 4 | 12-FREN-1 | 2.5 cm (1.0") diameter tree |
| 5 | 12-FLEN-1 | 17.8 cm (7.0") diameter x 35.6 cm (14.0") tall rotted tree trunk |
| 6 | 12-FCEN-1 | 1.9 cm (0.75") diameter tree |
| 7 | 12-FREN-1 | 7.6 cm (3.0") diameter tree |
| 8 | 12-FLEN-1 | 3.8 cm (1.5") diameter tree |
| 9 | 12-FLEN-1 | 5.1 cm (2.0") diameter tree |
| 10 | 12-FCEW-4 | 48.3 cm (19.0") diameter tree |

The driver's door remained closed during the crash and the latch was operational post-crash. The door, however, was restricted in the closed position due to the cutting of the B-pillar during the extrication efforts. The right door was jammed closed by exterior deformation. The door was cut from the vehicle during the rescue activities. All six upper roof pillars were cut for the removal of the roof.

The windshield was cracked by occupant contact and exterior deformation. The driver's head penetrated the windshield right of the centerline of the vehicle. Rescue personnel cut the laminated windshield during the removal process of the roof. The driver's door glazing (fully closed), both rear quarter glazing, and the backlight were shattered by rescue personnel during the roof removal. The right door glazing was fully closed at the time of the crash and remained intact following the removal of the door from the vehicle.

The hood latch remained engaged during the crash and both hood hinges remained intact. The hood buckled at the designated fold points. The rear aspect of the hood folded vertically against, or in close proximity to the windshield. The front right passenger's head impacted the hood as he contacted the windshield during his forward trajectory. The area of the head contact was located 22.2-29.8 cm (8.75-11.75") inboard of the right hood edge and 3.8-15.2 cm (1.5-6.0") above the rear edge.

Interior Damage –1995 Pontiac Grand Prix

The 1995 Pontiac Grand Prix sustained severe interior damage as result of intrusion and occupant contacts. The driver loaded the steering assembly, which compressed the energy absorbing steering column. The left shear bracket was displaced 1.9 cm (0.75") and the right shear bracket was displaced 4.0 cm (1.6"). There was no deformation of the steering wheel rim or spokes. The driver's right knee impacted and deformed the lower center instrument panel and subpanel. The contact produced a 6.4 cm (2.5") deep area of deformation that was centered 50.1 cm (20.0") below the top of the instrument panel. The right knee engaged the wiring harness that was contained within the lower center instrument panel. There was no contact evidence to the knee bolster.

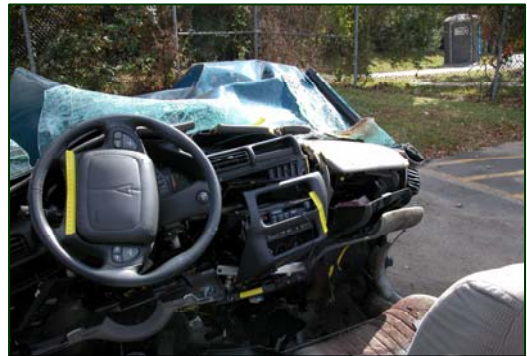


Figure 8. Driver's trajectory and contact points.

The driver contacted the center mounted radio trim panel. The panel was fractured and displaced forward from contact with his right torso. The top aspect of the right center instrument panel was fractured and displaced forward from probable contact with the driver's chin or right arm. The area of contact was located 15.2-27.9 cm (6.0-11.0") right of center. His head continued forward and impacted the windshield right of the vehicle's centerline. Hair was embedded into the cracked windshield glazing 30.5 cm (12.0") above the top instrument panel. The investigating police officer stated that the driver was found in the vehicle with his head penetrated through the windshield. **Figure 8** is a view of the driver's trajectory and contact points.

The front right passenger's knees contacted the glove box door. His left knee scuffed and fractured the door 7.6-12.7 cm (3.0-5.0") right of the left edge of the door and 20.3-30.5 cm (8.0-12.0") below the top of the door. The front right passenger was presumably slumped pre-crash, which allowed his head to contact the leading edge of the front right passenger air bag module cover. Hair was embedded in the leading edge and the cover flap was rotated forward, similar to a deployed flap position. Blood was also noted on the non-deployed front right air bag membrane. The front right passenger subsequently impacted the windshield with his head 22.9 cm (9.0") inboard of the right A-pillar and 12.7-33.0 cm (5.0-13.0") above the bottom edge of the glazing. Hair and blood deposits were noted in this area of contact. The front right



Figure 9. Overall view of front right area and the passenger's contact points.

passenger's head contacted the deformed hood as he penetrated the windshield a dent was located 23.4-30.0 cm (8.8-11.8") inboard of the right hood edge and 3.8-15.2 cm (1.5-6.0") forward of the rear hood edge and measured approximately 1.3 cm (0.5") in depth. **Figure 9** is an overall view of the front right area and the passenger's contact points.

The passenger compartment was reduced in size by intrusion of frontal components. The interior intrusions are listed in the table below:

Table 2. Intrusions

| Component | Magnitude of Intrusion | Direction |
|-------------------------|------------------------|--------------|
| Left instrument panel | 45.7 cm (18.0") | Vertical |
| Left toe pan | 31.1 cm (12.25") | Longitudinal |
| Left floor | 2.5 cm (1.0") | Vertical |
| Center instrument panel | 13.9 cm (5.5") | Vertical |
| Center toe pan | 50.8 cm (20.0") | Longitudinal |
| Right instrument panel | 24.1 cm (9.5") | Vertical |
| Right toe pan | 30.5 cm (12.0") | Longitudinal |

Event Data Recorder - 1995 Pontiac Grand Prix

The 1995 Pontiac Grand Prix was equipped with a Sensing and Diagnostic Module (SDM) that had EDR capabilities. The EDR was mounted to the floor of the vehicle, under the front right seat (**Figure 10**). Although the 12-volt battery power was retained following the crash, the EDR could not be downloaded through the diagnostic port. This connector could not be located within the passenger compartment of the vehicle. Due to a potential biohazard of pooled blood on the floor of the vehicle, the police reconstructionist requested the services of the local fire department to remove the front right seat to allow for full, unimpeded access to the EDR. The fire fighters used hydraulic equipment to remove the seat. Although the fire fighters removed the roof and right front door post-crash, they failed to disconnect the battery or cut the cables prior to initiating their extrication activities.

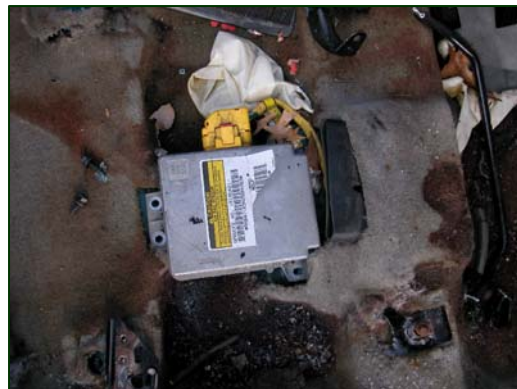


Figure 10. Mounted position of the EDR prior to removal from vehicle.

Following the removal of the front right passenger seat, the EDR was unbolted from the floor mount of the vehicle. The EDR was placed in the officer's police vehicle where an auxiliary 12-volt power supply was available. The Vetronix Crash Data Retrieval (CDR) System was used to download the EDR. The EDR recorded two events that were associated with this crash, a Non-deployment and Deployment event. Although a Deployment event was recorded, the frontal air bag system did not deploy. The EDR data indicated the driver's safety belt was unbuckled at the time of the crash. The first event recorded by the EDR was the Non-Deployment that was possibly associated with the embankment impact. The maximum recorded velocity change for this event was -0.35 km/h (-0.22 mph). This event would have produced a crash pulse to all three axes (X, Y, and Z) due to the frontal undercarriage impact while in a counterclockwise yaw. The EDR also recorded a Deployment event that occurred 0.21 seconds subsequent to the

Non-Deployment event. Reconstruction of the crash suggests that this event was probably associated with the multiple closely spaced impacts with the small diameter trees. The EDR maximum recorded velocity change for the Deployment event was -17.83 km/h (-11.08 mph). This velocity change was recorded at 300 milliseconds. An analysis of this EDR's crash pulse indicated the deployment event was a long duration event with a moderately low velocity change. The time from algorithm enable to deployment command was 162.5 milliseconds. It was probable that the long duration crash pulse suppressed the system's command to deploy the frontal air bag system. The EDR download is included in this report as **Attachment A**.

Frontal Air Bag System - 1995 Pontiac Grand Prix

The 1995 Pontiac Grand Prix was equipped with frontal air bags for the driver and front right passenger positions. The driver's air bag was located within the steering wheel hub and was concealed by I-configuration module cover flaps. The front right air bag was located on the top of the right instrument panel. A single forward hinged cover flap concealed the front right air bag. The air bag system did not deploy in this crash (**Figures 11 and 12**).



Figure 11. Non-deployed driver's frontal air bag.



Figure 12. Non-deployed front right frontal air bag.

Automatic Safety Belt System – 1995 Pontiac Grand Prix

The 1995 Pontiac Grand Prix was equipped with automatic door mounted 3-point lap and shoulder safety belts for the front outboard seating positions (**Figure 13**). The front safety belts were configured with sewn-on latch plates and Emergency Locking Retractors (ELR's). No crash related evidence such as stretching, transfers etc., were noted to the safety belts which was indicative of the driver and front right passenger not utilizing the safety belts in this crash. The rear seat was equipped with manual 3-point lap and shoulder belts and a 2-point lap belt for the center rear position. The rear outboard safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractor's (ALR's). The rear center safety belt was configured with a locking latch plate and no retractor.



Figure 13. Front right 3-point automatic safety belt system.

Occupant Demographics – 1995 Pontiac Grand Prix

Driver

Age/Sex: 21-year-old/Male
 Height: Unknown
 Weight: 115 kgs (254 lbs)
 Seat Track Position: Seat track was adjusted to the full rear position [track travel = 21.6 cm (8.5”)]
 Safety Belt Usage: None, equipped with 3-point door mounted automatic safety belts
 Usage Source: Vehicle inspection, observation of first responders
 Eyewear: Unknown
 Type of Medical Treatment: Transported by ambulance to local hospital. Admitted for five days and released.

Driver Injuries

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|--|---|-------------------------------|
| Open/displaced fracture of the mid-shaft of the right tibia | Serious (853422.3,1) | Lower center instrument panel |
| C5 burst fracture with cord contusion | Serious (640204.3,6) | Indirect windshield |
| Open/displaced fracture of the right mid-shaft of the fibula | Moderate (851610.2,1) | Lower center instrument panel |
| C7 upper end plate compression fracture | Moderate (650230.2,6) | Indirect windshield |
| Right renal contusion | Moderate (541610.2,1) | Lower center instrument panel |
| 4.0 cm (1.6”) laceration to the right occipital scalp | Minor (190602.1,6) | Windshield |
| Laceration to the bridge of the nose | Minor (290600.1,4) | Windshield |
| Nasal fracture NFS | Minor (251002.1,4) | Windshield |
| Abrasion over right knee | Minor (890202.1,1) | Lower center instrument panel |
| 2.0 cm (0.8”) laceration to the anterior right knee | Minor (890602.1,1) | Lower center instrument panel |
| Rotation of C1 and C2 | Not coded under AIS | Indirect windshield |

Source of medical data = Discharge and Emergency Records

Driver Kinematics

The 21-year old male driver of the 1995 Pontiac Grand Prix was seated in a presumed upright driving posture. He was not restrained by the automatic door mounted 3-point lap and shoulder belt system. As the vehicle began the counterclockwise rotation, the driver was displaced slightly out-of-position to his right. At the impact with the embankment, the driver continued the forward and right trajectory, and bottomed into the seat cushion which lowered his seated height in the vehicle. The vehicle continued forward and impacted a delineator post and seven small

diameter trees. These impacts were minor in nature and did not displace the driver forward. At impact with the 48.3 cm (19.0”) diameter tree, the driver was out-of-position to his right. He responded to the 12 o’clock direction of force by moving forward. The driver contacted the lower center instrument panel which resulted in the open/displaced fracture of the mid-shaft of the right tibia, open/displaced fracture of the mid-shaft of the fibula, abrasion over right knee, 2.0 cm (0.8”) laceration to the anterior right knee, and the right renal contusion. The driver continued forward and impacted the windshield which he penetrated with his head. The resulting injuries from the windshield contact were the 4.0 cm (1.6”) laceration to the right occipital scalp, laceration to the bridge of the nose, nasal fracture. The windshield contact arrested the forward movement of his head. His body continued forward resulting in the hyperflexion of the neck. The resulting indirect injuries were the C5 burst fracture with cord contusion, C7 upper end plate compression fracture, and the rotation of C1 and C2. He came to rest with his head engaged through the windshield in a conscious state. The driver was removed from the vehicle by rescue personnel and transported to a local hospital where he was admitted for five days and released.

Medical Treatment

The driver underwent open reduction and internal fixation surgery for the fractured right tibia and fibula. The medical report noted that the driver should contact a plastic surgeon to facilitate the reconstruction surgery of his fractured nose. The driver was discharged five days post-crash.

Front Right Passenger

Age/Sex: 37-year old/Male
 Height: 171.5 cm (67.5”)
 Weight: 80.0 kgs (176.5 lbs)
 Seat Track Position: Seat track was adjusted to the rear third, 5.1 cm (2.0”) forward of full rear [total track travel = 15.2 cm (6.0”)]
 Safety Belt Usage: None, equipped with door mounted automatic safety belts
 Usage Source: Vehicle inspection, observation of first responders
 Eyewear: Unknown
 Type of Medical Treatment: Transported by ambulance to a local hospital where he was pronounced deceased.

Front Right Passenger Injuries

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanism |
|---|---|-------------------------|
| Cerebral edema with left uncal grooving and cerebellar tonsillar coning | Critical (140202.5,8) | Hood |
| Multiple cerebral subarachnoid hemorrhages | Serious (140684.3,9) | Hood |
| Multiple cerebellar subarachnoid hemorrhages | Serious (140466.3,6) | Hood |
| Multiple bilateral contusions to the temporal and frontal lobes | Serious (140620.3,3) | Hood |
| 8.9 cm (3.5”) linear fracture to the right temporal and occipital bones | Moderate (150402.2,1) (150402.2,6) | Hood |

| | | |
|--|-----------------------|---|
| Mid-sternum non-displaced fracture | Moderate (450804.2,4) | Right instrument panel |
| Cecal contusion to large intestine | Moderate (540810.2,8) | Right instrument panel |
| Subgaleal hemorrhage below right occipital bone | Minor (190402.1,6) | Hood |
| 7.6 cm x 5.1 cm (3.0" x 2.0") right forehead abrasions | Minor (290202.1,7) | Windshield |
| 4.6 cm x 2.5 cm (1.8" x 1.0") right cheek dicing abrasions | Minor (290202.1,1) | Windshield |
| 2.5 cm x 2.0 cm (1.0" x 0.8") left nasal bridge and tip abrasions | Minor (290202.1,4) | Windshield |
| Left forehead abrasion 3.3 cm (1.3"), curved linear abrasions and scattered abrasions less than 1.3 cm (0.5") | Minor (290202.1,7) | Windshield |
| Multiple linear abrasions to the anterior chin 9.7 cm x 5.1 cm (3.8" x 2.0") extending to the neck | Minor (290202.1,8) | Front right air bag cover flap (Non-Deployed) |
| Multiple linear abrasions to the anterior neck 9.7 cm x 5.1 cm (3.8" x 2.0") extending from the chin to the neck | Minor (390202.1,5) | Front right air bag cover flap (Non-Deployed) |
| 2.5 cm (1.0") laceration over the right eyebrow | Minor (290202.1,7) | Windshield |
| 1.3 cm (0.5") laceration to the posterior scalp | Minor (190602.1,6) | Windshield |
| 3.8 cm (1.5") laceration to the right occipital scalp | Minor (190602.1, 6) | Windshield |
| 6.4 cm (2.5") posterior neck laceration | Minor (390602.1,6) | Windshield |
| 1.3 cm (0.5") abrasion to the right anterior shoulder | Minor (790202.1,1) | Right instrument panel |
| 6.4 cm x 2.5 cm (2.5" x 1.0") contusion superior to the right nipple | Minor (490402.1,1) | Right instrument panel |
| 7.6 cm x 3.8 cm (3.0" x 1.5") right elbow abrasion | Minor (790202.1,1) | Right instrument panel |
| Multiple 1.3 cm (0.5") abrasions to the left wrist | Minor (790202.1,2) | Right instrument panel |
| 1.3 cm (0.5") round abrasion to the lateral aspect of the left 3 rd finger | Minor (790202.1,2) | Right instrument panel |
| 1.3 cm (0.5") abrasion to the dorsum left hand | Minor (790202.1,2) | Right instrument panel |

| | | |
|--|--------------------|---------------------------------|
| 2.5 cm x 2.5 cm (1.0" x 1.0") abrasion to the anterolateral right knee | Minor (890202.1,1) | Glove box door |
| 3.8 cm x 1.3 cm (1.5" x 0.5") anterior left leg abrasion | Minor (890202.1,2) | Glove box door |
| 19.0 cm (7.5") linear abrasion to the posterior left calf | Minor (890202.1,2) | Lower right instrument panel |

Source of medical data = Autopsy

Front Right Passenger Kinematics

The 37-year old male front right passenger was seated in an unknown posture. He was not restrained by the automatic door mounted 3-point lap and shoulder belt system. As the vehicle began the counterclockwise rotation, the passenger was displaced to his right. The vehicle continued forward and impacted an earth embankment, a delineator post, and seven small diameter trees. The delineator and seven trees impacts were minor in nature and did not displace the passenger forward. The passenger probably loaded the seat cushion as a result of the undercarriage impact to the embankment. This bottoming action could have displaced him from a more upright position. The vehicle continued forward and impacted a 48.3 cm (19.0") diameter tree with the center frontal area. This impact displaced the passenger in a forward direction. His legs contacted the glove box door and lower right instrument panel which resulted in the 19.0 cm (7.5") linear abrasion to the posterior left calf, 3.8 cm x 1.3 cm (1.5" x 0.5") anterior left leg abrasion, 2.5 cm x 2.5 cm (1.0" x 1.0") abrasion to the anterolateral right knee. The passenger's torso contacted the right instrument panel which resulted in the mid-sternum non-displaced fracture, cecal contusion to large intestine, 1.3 cm (0.5") abrasion to the anterior shoulder, 6.4 cm x 2.5 cm (2.5" x 1.0") contusion superior to the right nipple, 7.6 cm x 3.8 cm (3.0" x 1.5") right elbow abrasion, multiple 1.3 cm (0.5") abrasions to the left wrist, 1.3 cm (0.5") round abrasion to the lateral aspect of the left 3rd finger, and a 1.3 cm (0.5") abrasion to the dorsum left hand.

This contact momentarily arrested the forward motion of his pelvic and torso areas, which induced a forward and downward trajectory of his head. The passenger's head contacted the leading edge of the front right air bag module cover which was evidenced by hair that was embedded into the flap edge. The contact to the air bag cover flap resulted in the multiple linear abrasions to the anterior chin 9.7 cm x 5.1 cm (3.8" x 2.0") extending to the neck, and multiple linear abrasions to the anterior neck 9.7 cm x 5.1 cm (3.8" x 2.0") extending from the chin to the neck. His head continued forward and impacted and penetrated the lower right corner of the windshield, which was evidenced by blood and hair embedded into the cracked laminated glass. The windshield contact resulted in the 7.6 cm x 5.1 cm (3.0" x 2.0") right forehead abrasions, 4.6 cm x 2.5 cm (1.8" x 1.0") right cheek abrasions and dicing, 2.5 cm x 2.0 cm (1.0" x 0.8") left nasal bridge and tip abrasions, left forehead abrasion 3.3 cm (1.3"), curved linear abrasions and scattered abrasions less than 1.3 cm (0.5"), 2.5 cm (1.0") laceration over the right eyebrow, 1.3 cm (0.5") laceration to the posterior scalp, 3.8 cm (1.5") laceration to the right occipital scalp, and a 6.4 cm (2.5") posterior neck laceration.

The passenger's head penetrated the windshield and contacted the hood that folded rearward and was positioned in close proximity to the windshield at the moment of the head contact. The

passenger's head subsequently loaded the hood, denting the surface of the hood resulting in the cerebral edema with left uncal grooving and cerebellar tonsillar coning, multiple cerebral subarachnoid hemorrhages, multiple bilateral contusions to the temporal and frontal lobes, and a 8.9 cm (3.5") linear fracture to the right temporal and occipital bones, and subgaleal hemorrhage underneath right occipital bone. He came to rest slumped forward against the upper right instrument panel.

Medical Treatment

The front passenger was removed from the vehicle by rescue personnel and transported by ambulance to a local emergency medical facility. The medical report noted that it was a prolonged extrication process. EMS personnel began CPR efforts when he was removed from the vehicle and continued CPR while in transport to the medical facility. CPR continued upon arrival; however, the revival efforts were not successful and he was pronounced deceased shortly upon arrival to the medical facility. An autopsy was performed which detailed the nature and severity of his injuries.

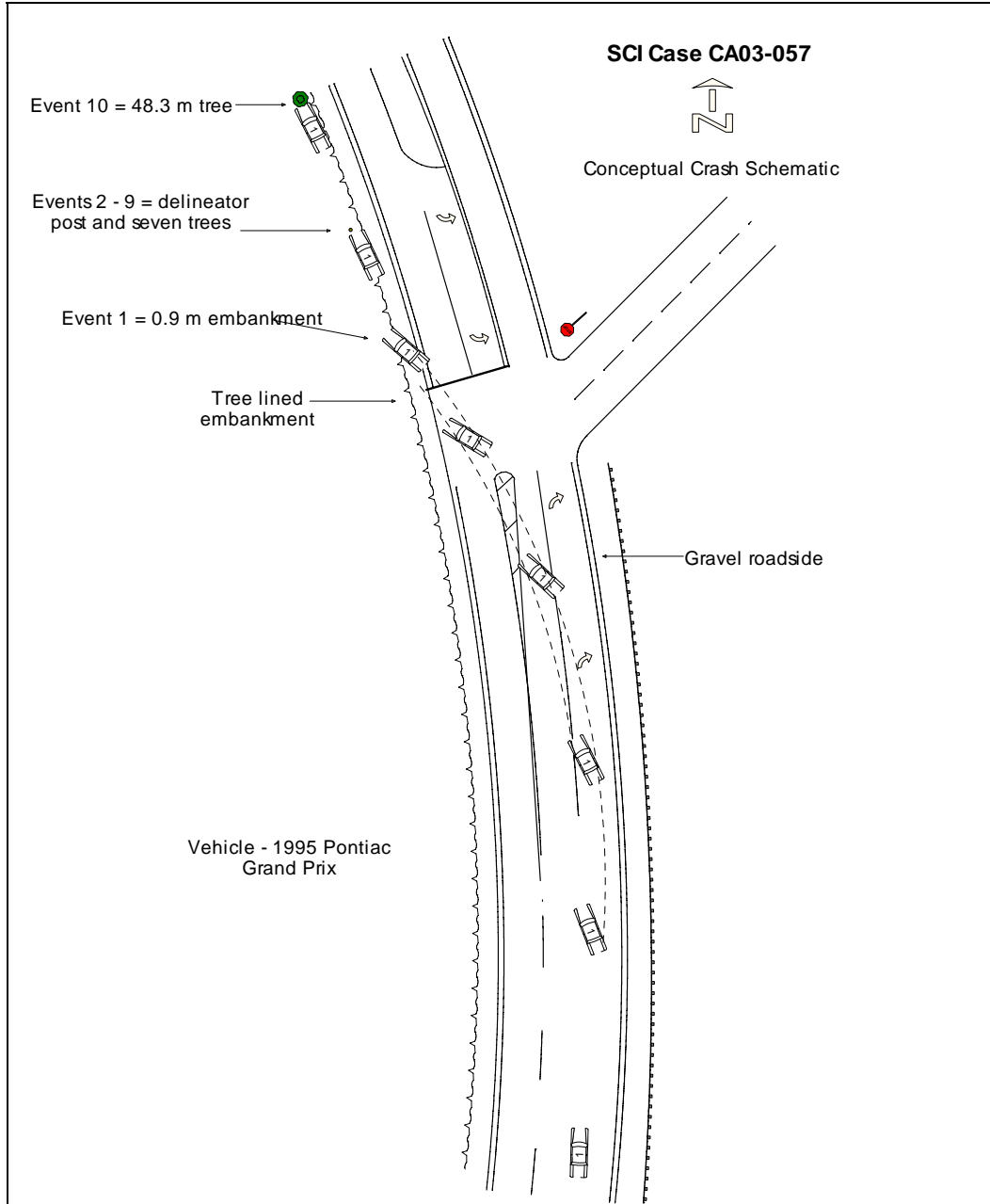


Figure 14: Scene Schematic

Attachment A: EDR data

CDR File Information

| | |
|--|---|
| Vehicle Identification Number | 1G2WJ12M3SFxxxxxx |
| Investigator | |
| Case Number | CA03057 |
| Investigation Date | |
| Crash Date | |
| Filename | EDR.CDR |
| Saved on | Wednesday, October 22 2003 at 02:21:14 PM |
| Data check information | FEB3E66D |
| 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 | Crash 1 Deployment Non-Deployment |

SDM Data Limitations

SDM Recorded Crash Events:

There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded forward velocity change. This event will be cleared by the SDM after the ignition has been cycled 125 times.

The second type of SDM recorded crash event is the Deployment Event. The SDM can store up to two different Deployment Events. The first deployment event will be stored in the #1 Deployment file (this would have been the event that deployed the air bag) and the second Deployment Event will be stored in the #2 Deployment file. Deployment events can not be overwritten or cleared from the SDM. Once the SDM has two deployments recorded, the SDM must be replaced.

The data in the non-deployment file will be locked after a deployment, if the non-deployment occurred within 7.65 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. The SDM records the first 300 milliseconds of Vehicle Forward Velocity Change after Algorithm Enable. The maximum value that can be recorded for Vehicle Forward Velocity Change is 28 MPH.

-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 five 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. An indication of a loss of power would be if the ignition cycles at Deployment or Non-Deployment is recorded as zero. Data recorded after that may not be reliable, such as Time Between Non-Deployment and Deployment Events and Driver Belt Switch Circuit Status.

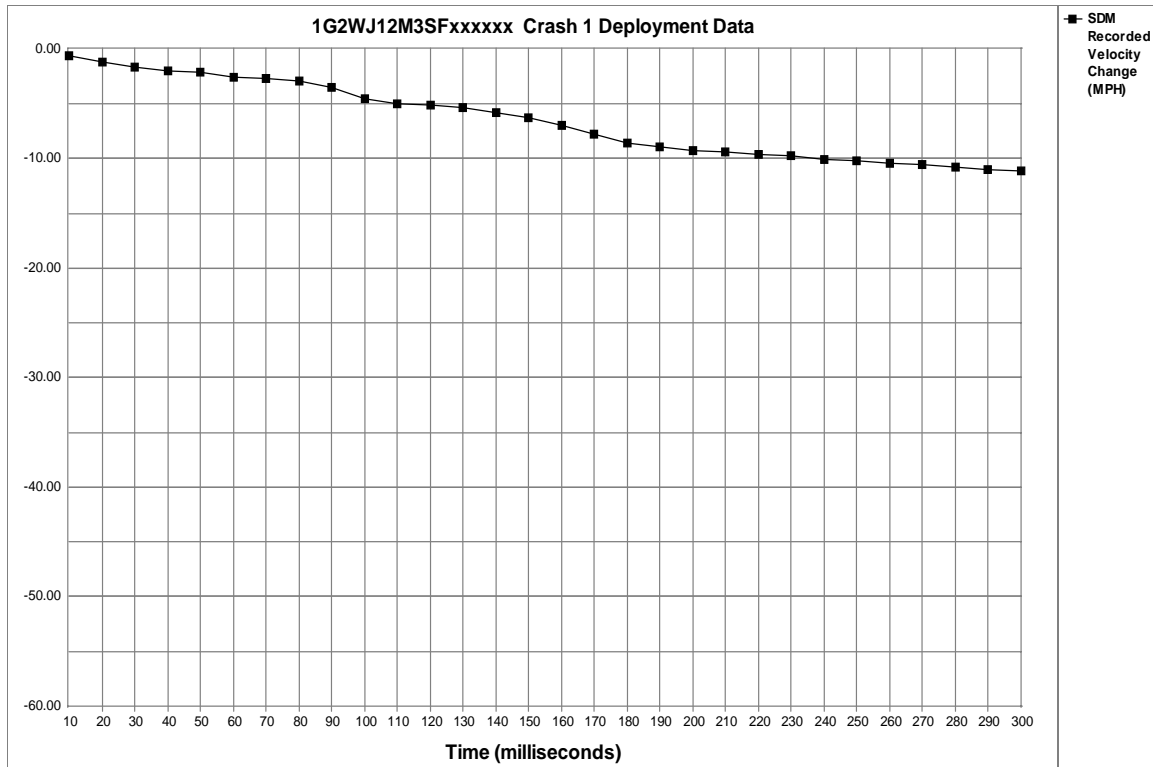
SDM Data Source:

All SDM recorded data is measured, calculated, and stored internally, except for the following:

-The Driver's Belt Switch Circuit is wired directly to the SDM.

System Status At Crash 1

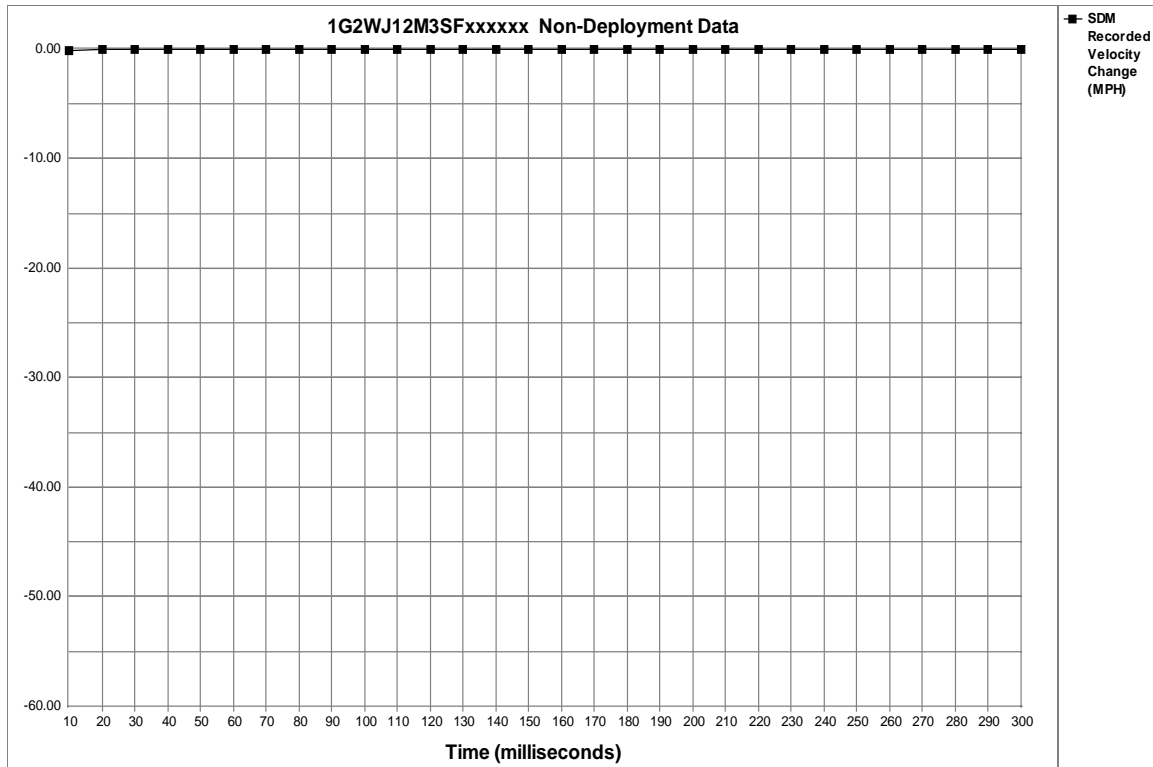
| | |
|--|-----------|
| SIR Warning Lamp Status | OFF |
| Driver's Belt Switch Circuit Status | UNBUCKLED |
| Ignition Cycles At Deployment | 10026 |
| Ignition Cycles At Investigation | 10029 |
| Time From Algorithm Enable to Deployment Command Criteria Met (msec) | 162.5 |
| Time Between Non-Deployment And Deployment Events (sec) | .21 |



| | | | | | | | | | | | | | | | |
|--------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|--------|--------|--------|--------|--------|--------|--------|
| Time (milliseconds) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 |
| Recorded Velocity Change (MPH) | -0.55 | -1.21 | -1.65 | -1.97 | -2.08 | -2.52 | -2.63 | -2.85 | -3.51 | -4.50 | -4.94 | -5.05 | -5.38 | -5.81 | -6.25 |
| Time (milliseconds) | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 | 260 | 270 | 280 | 290 | 300 |
| Recorded Velocity Change (MPH) | -6.91 | -7.79 | -8.56 | -8.89 | -9.21 | -9.32 | -9.54 | -9.76 | -10.09 | -10.20 | -10.42 | -10.53 | -10.75 | -10.97 | -11.08 |

System Status At Non-Deployment

| | |
|---|-----------|
| SIR Warning Lamp Status | OFF |
| Driver's Belt Switch Circuit Status | UNBUCKLED |
| Ignition Cycles At Non-Deployment | 10026 |
| Ignition Cycles At Investigation | 10029 |
| Algorithm Enable to Maximum SDM Recorded Velocity Change (msec) | 2.5 |
| Maximum SDM Recorded Velocity Change (MPH) | -0.22 |
| A Deployment was Commanded Prior to this Event | No |



| | | | | | | | | | | | | | | | |
|--------------------------------|-------|------|------|------|------|------|------|------|------|------|------|------|------|------|------|
| Time (milliseconds) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 |
| Recorded Velocity Change (MPH) | -0.11 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Time (milliseconds) | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 | 260 | 270 | 280 | 290 | 300 |
| Recorded Velocity Change (MPH) | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |

Hexadecimal Data

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

```
B600: 25 09 C0 01 00 00 00 00
B608: 00 55 00 00 00 28 1D F9
B610: F9 F9 F9 F9 F9 F9 00 64
B618: 02 75 FD 53 AA FB 00 00
B620: AA AA 00 AA 00 00 81 00
B628: 08 40 82 05 0B 0F 12 13
B630: 17 18 1A 20 29 2D 2E 31
B638: 35 39 3F 47 4E 51 54 55
B640: 57 59 5C 5D 5F 60 62 64
B648: 65 27 2A FF 07 00 80 55
B650: AA AA 55 AA 00 00 00 00
B658: 00 00 00 00 00 00 00 00
B660: 00 00 00 00 00 00 00 00
B668: 00 00 00 00 00 00 00 00
B670: 00 00 00 00 00 00 00 00
B678: 00 00 00 00 00 00 00 00
B680: 00 00 00 00 00 00 00 00
B688: 7D 00 00 00 02 02 01 00
B690: 00 00 00 00 00 00 00 00
B698: 00 00 00 00 00 00 00 00
B6A0: 00 00 00 00 00 00 00 00
B6A8: 00 00 00 00 27 2A 00 80
B6B0: 55 AA AA AA AA 00 00 00
B6B8: 7D 00 00 7D 00 00 81 00
B6C0: 01 82 00 01 83 00 00 00
B6C8: 00 00 7D 00 00 7D 00 00
B6D0: 00 00 00 47 10 43 94 28
B6D8: 04 28 30 41 53 64 71 4B
B6E0: 00 00 00 33 57 01 00 00
B6E8: 00 00 00 00 00 00 10 20
B6F0: F3 70 06 F0 05 50 25 64
B6F8: FF FF FF FF FF FF FF FF
B700: FF FF FF 60 60 60 60 60
B708: 60 60 60 60 60 60 60 7F
B710: 9F A5 AA B1 B9 C1 C8 D1
B718: D9 E3 EC F8 41 43 46 48
B720: 4B 4E 50 53 55 58 5B 5E
B728: 60 63 65 67 6A 6D 70 73
B730: 76 7A 7C 80 82 85 87 89
B738: 8B 8D 8E 90 91 92 94 95
B740: 96 97 97 98 99 99 9A 9B
B748: 9B 9B 9C 9D 9D 9D 9E 9E
B750: 9F 9F 9F 9F 9F 9F A0 A0
B758: A0 A0 A0 A0 10 1C 39 00
B760: 00 00 00 00 00 00 00 00
B768: 00 00 00 00 00 00 15 17
B770: 18 19 1C 1E 20 23 24 25
B778: 27 29 2B 00 00 00 00 00
B780: 00 00 00 00 00 00 00 00
B788: 00 00 00 00 00 00 00 00
B790: 00 00 00 00 00 00 00 AA
B798: 00 13 00 13 00 2D 4B 16
B7A0: 06 18 01 02 AA 02 4B 4C
B7A8: FF FF FF FF FF FF FF FF
B7B0: FF FF FF 57 57 57 57 57
B7B8: 57 57 57 57 57 57 57 5B
B7C0: 60 60 60 62 62 64 66 68
B7C8: 68 6A 6D 70 85 85 85 85
B7D0: 85 85 85 85 87 8A 8F 91
B7D8: 91 97 99 9C 9F A2 A5 A7
B7E0: AA AC AE B0 B2 B4 B6 B7
B7E8: B9 BA BC BD BE C0 CB D3
```

B7F0: DA E0 E6 FF FF FF FF FF
B7F8: CA 8C A5 A5 A5 A5 00 80