

CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE AIR BAG NON-DEPLOYMENT INVESTIGATION

CASE NO: CA05-049

VEHICLE: 2005 CHEVROLET COBALT

LOCATION: MARYLAND

CRASH DATE: JULY 2005

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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CALSPAN ON-SITE AIR BAG NON-DEPLOYMENT INVESTIGATION
CASE NO: CA05-049
VEHICLE: 2005 CHEVROLET COBALT
LOCATION: MARYLAND
CRASH DATE: JULY 2005

BACKGROUND

This on-site investigation focused on the severity of the crash, the download of the vehicle's onboard Event Data Recorder (EDR), the non-deployed status of the vehicle's driver air bag system, and the injuries and cause of death for the 16-year old female driver of a 2005 Chevrolet Cobalt (**Figure 1**). The Cobalt was equipped with dual stage frontal air bags for the driver and front right positions. The driver of the Cobalt was unrestrained as the vehicle departed a residential cul-de-sac and struck a large diameter tree with the front right area resulting in severe frontal damage.



Figure 1. Subject vehicle 2005 Chevrolet Cobalt.

The frontal air bag system did not deploy in the crash. The driver initiated a forward trajectory and loaded the steering assembly. Her loading of the alloy steering wheel rim fractured the wheel flange, thus separating the wheel from the column. The vehicle rotated in a clockwise direction and impacted several small diameter trees with the left side area, which resulted in a lateral rollover onto its right side. The driver came to rest slumped against the right door and remained conscious at the scene. Rescue personnel arrived on-scene and administered emergency treatment. As the driver was moved from her final rest position, she lapsed into an unconscious state and was without a pulse. She was immediately transported by ambulance to a local hospital where she expired within two hours of the crash of severe liver lacerations.

The investigating officer reported the crash to NHTSA's Office of Defects Investigations. The notification was forwarded to the Calspan Special Crash Investigations team on August 15, 2005, and was assigned for on-site investigation due to the reported non-deployed status of the driver's air bag. Cooperation was established with the officer and an on-site investigation was conducted on August 26. The on-site investigation involved a thorough inspection and documentation of the vehicle, downloading of the Cobalt's EDR, and documentation of the crash scene.

SUMMARY

Crash Site

The crash occurred in a remote, rural residential area at the end of a cul-de-sac roadway during dark, nighttime hours. At the time of the crash, the weather conditions were police reported as overcast with wet environmental surfaces from a previous rainfall. A two-lane asphalt surfaced roadway terminated at a 29.8 m (98') diameter cul-de-sac, which formed a circular loop to the right of the approach roadway. The roadway was 6.4 m (21') in width and was bordered by grass/vegetation with no stabilized shoulders. A 17 m (55.8') diameter grass circle was centered within the cul-de-sac. The posted speed limit for the area was 40 km/h (25 mph). There were no lane lines or edge line markings on the road. A residential driveway intersected the cul-de-sac at the top, left aspect of the circle, with respect to vehicle travel. Numerous trees and a rock-landscaped area bordered the edges of the driveway and the cul-de-sac. At the crash site, the initial impact involved a 13 cm (5") diameter (soft wood) tree, a 51 cm (20") diameter oak tree, and four small trees that ranged in diameters of 5-13 cm (2-5"). The scene schematic is included as **Figure 11**.

Vehicle Data

The subject vehicle in this crash was a 2005 Chevrolet Cobalt LS two-door sedan. The driver's parents purchased the Cobalt new and the 16-year old female driver was a frequent driver of the vehicle. The following Vehicle Identification Number (VIN) 1GAL12F857 (production number omitted) identified the Chevrolet. The Cobalt was equipped with a 2.2 liter DOHC ECOTEC 4-cylinder transverse mounted engine, linked to a four-speed automatic transmission with a console mounted shift selector. The service brakes were power-assisted front disc/rear drum with anti-lock (ABS). The Cobalt was equipped with OEM Pirelli P6 P205/55R16 radial tires that were mounted on OEM five-spoke alloy wheels. The manufacturer's recommended tire pressure for this vehicle was 206 kPa (30 PSI) front and rear with a tire maximum pressure of 302 kPa (44 PSI). The specific data for the tires at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
LF	0 kPa	6.4 mm (8/32")	Inner bead of wheel fractured
LR	189 kPa (27.5 PSI)	7.0 mm (10/32")	None
RF	0 PSI	6.4 mm (8/32")	Extensive fractures of inner wheel
RR	202 kPa (29.5 PSI)	7.0 mm (10/32")	None

The interior of the Cobalt was configured with front bucket seats with adjustable head restraints and manual track adjusters. Both head restraints were found to be in the full down positions. The rear seat was a three-passenger 60/40-split bench seat with integral head restraints for the outboard-seated positions. All interior seated surfaces were cloth. The Cobalt was equipped with manually operated windows and door locks. The outboard rear seat positions were equipped with LATCH (**L**ower **A**nchors and **T**op tethers for **C**hildren).

Crash Sequence

Pre-Crash

The 16-year old female driver was attending a house party at a residence located at the mouth of the cul-de-sac. She was under the influence of alcohol with a toxicology reported BAC of .17. The driver was not restrained by the manual 3-point lap and shoulder belt safety system. The lack of belt usage was determined from the vehicle inspection and EDR data. She left the party alone during the nighttime hours and attempted to exit the rural subdivision. For an unknown reason, the driver returned toward the cul-de-sac, traveling in a southerly direction on the left side of the two lane non-delineated roadway (**Figure 2**).



Figure 2. Pre-crash travel direction and overall view of the crash site.

The EDR recorded pre-crash data for a five-second interval prior to the Non-Deployment record. These data points indicated that the driver was accelerating at 100 percent throttle with a constant increase in engine RPMs and vehicle speed throughout this timeframe. The Cobalt's speed increased from 85 km/h (53 mph) at the five-second interval to 111 km/h (69 mph) at one-second of Algorithm Enable (AE). There was no evidence of braking at the crash site, and the EDR did not record brake application during the five-second pre-crash intervals.

Crash

As the Cobalt traversed the mouth of the driveway, the undercarriage overrode the landscaping, which consisted of flush mounted rocks within the dirt and mulch. The front left area of the vehicle narrowly missed a large rock that was positioned vertically within the landscaped area. The Cobalt continued forward in a tracking mode and impacted a 13 cm (5") diameter pine tree with the front left area of the vehicle. The resultant direction of force for this impact event was 12 o'clock. The impact uprooted the tree, but did not fracture the 13 cm (5") trunk. The Cobalt carried the tree forward as this impact produced a minimal velocity change to the vehicle. (The delta V could not be calculated due to the masking of damage by the subsequent impact). **Figure 3** is an overall view of the crash site.



Figure 3. Overall view of the crash site.

The Cobalt continued forward an additional 2.3 m where it struck a 51 cm (20") diameter hardwood tree with the front right area (**Figure 4**). At impact, the vehicle was in a near tracking attitude, and may have rotated slightly counterclockwise as a result of the initial

small diameter tree impact that was located left of center. This impact was located outboard of the right frame rail and involved the corner area of the Cobalt. The resultant direction of force was within the 12 o'clock sector. (The EDR calculated PDOF was 15 degrees).

As the front bumper beam crushed to a depth of 110 cm (43.4"), the right front tire and wheel engaged the tree. The engagement fractured the alloy wheel and axle, and front suspension components, separating the wheel and brake assembly. The crush extended onto the right side plane of the Cobalt, engaging the right A-pillar and leading edge of the right door. The damage algorithm of the WinSMASH program computed a total velocity change of 61 km/h (37.9 mph) with longitudinal and lateral components of -60 km/h (-37.3 mph) and -11 km/h (-6.8 mph) respectively. The EDR recorded a maximum velocity change of 80 km/h (49.99 mph) at 300 msec of Algorithm Enable (AE). The frontal air bag system did not deploy. Due to the offset right crash, the Cobalt began to rotate in a clockwise (CW) direction as it separated from the tree.



Figure 4. Impact with the 51 cm (20'') diameter hardwood tree.



Figure 5. Area of impact with the four small diameter trees and final rest.

As the Cobalt rotated CW, the left side area impacted four small diameter trees that were located 2.8-4.6 m (9-15') south of the 51 cm (20'') diameter tree (**Figure 5**). The lateral impact deflected the trees, which resulted in a ramping effect as the undercarriage of the Cobalt rode up the trees. This ramping effect resulted in an overturn (flip-over) of the Cobalt as it rolled one-quarter turn onto its right side. The Cobalt continued to rotate approximately 40 degrees about its longitudinal axis prior to coming to rest on its side.

Post-Crash

The Cobalt came to rest on its right side, facing in a northeasterly direction (**Figure 6**). At rest, the vehicle was facing in a direction that was nearly opposite of its initial travel direction. Volunteer fire



Figure 6. On-scene image of the Cobalt at final rest.

fighters and Emergency Medical Service (EMS) personnel arrived on-scene. The fire personnel stabilized the vehicle as the EMS workers attended to the driver. She remained conscious and was conversing with the first responders; however, as she was moved from her rest position against the right door of the vehicle, the driver coded and became unconscious. She was transported by ambulance to a local hospital where she expired.

Vehicle Damage

Exterior

The 2005 Chevrolet Cobalt sustained severe front right damage as a result of the front right impact with the large diameter tree. The additional tree impacts produced minor severity damage to the front left and left area of the vehicle. The subsequent overturn of the vehicle onto its right side resulted in minor damage.

The initial impact with the 13 cm (5") diameter tree was located on the front left area of the vehicle (**Figure 7**). The direct contact damage began 29 cm (11.4") left of center and extended 11 cm (4.25") to the left. The impact dented the hood face to a maximum depth of 10 cm (4.0"). The damage and resulting crush to the bumper system was masked by the subsequent impact with the large diameter tree. The Collision Deformation

Classification for the impact was 12-FLEN-1.



Figure 7. Damage from the 13 cm (5") tree.



Figure 8. Overhead view of the damage from the 51 cm (20") tree.

The Cobalt uprooted and overrode the small diameter tree as it continued 2.3 m (7.5') forward and impacted the 51 cm (20") hardwood tree with the front right area (**Figure 8**). The direct contact damage began 41 cm (16.25") right of center and extended 33 cm (13") to the front right corner. The damage was concentrated outboard of the right frame rail and initially involved the corner of the bumper beam and sheet metal components. As the vehicle crushed, the right front tire/wheel and axle assembly engaged the tree followed by the right A-pillar area. The right corner impact deformed the full width of the frontal structure. The combined induced and direct contact damage at the bumper level measured 67 cm (26.5"), extending from corner-to-corner of the bumper beam. Maximum crush was measured at 110 cm (43.4"), located at the front right corner of the bumper beam. The crush profile at the level of the bumper beam was as follows: C1 = 12

cm (7.6”), C2 = 48 cm (18.75”), C3 = 56 cm (21.9”), C4 = 67 cm (26.5”), C5 = 80 cm (31.4”), C6 = 110 cm (43.4”).

As the Cobalt continued forward and began to rotate in a clockwise direction, the right front tire and wheel engaged the tree. This contact fractured the inner aspect of the alloy wheel rim and fractured the right front axle and suspension. The tire/wheel and brake assembly separated from the Cobalt. The right A-pillar engaged the tree and crushed the base of the pillar approximately 67 cm (26.5”) rearward. (It should be noted that the investigating officer stated that this area of the vehicle was pulled forward using hydraulic equipment as the officer interrogated the vehicle in search of the air bag control module.) The welded section of the right A-pillar, toe/floor pan, and the right sill separated due to the extensive crush and induced deformation. The CDC for this event was 12-FREE-7.

The left lateral impacts with the four small diameter trees produced minor severity damage to the left side of the vehicle. The position of these trees resulted in near simultaneous impacts. Three of the four tree impact sites were identified on the left side of the Cobalt. The left front axle position impacted a 10 cm (4”) diameter tree. This impact fractured the alloy wheel, de-beaded the tire, and fractured the left front suspension components. The mid aspect of the left sill area impacted a 13 cm (4”) diameter tree. This lateral impact dented the sill to a maximum depth of 3 cm (1.25”). The third lateral impact involved a 13 cm (5”) diameter tree. This impact was located on the sill, immediately forward of the left B-pillar. A 6 cm (2.5”) deep dent was noted to the left sill. The fourth left side tree impact did not produce distinct damage associated with this event. This small diameter tree measured 5 cm (2”) in diameter. The undercarriage of the passenger compartment was minimally involved with the trees as they were deflected laterally, allowing the Cobalt to ramp up the trees and overturn. The ramping effect of the yielding trees reduced the overall crash severity of these impacts. The CDC’s for these impacts are listed in the following table:

Crash Event No.	Object Struck	CDC
3	10 cm tree	09-LFEN-1
4	13 cm tree	09-LPLN-2
5	13 cm tree	09-LPLN-3
6	5 cm tree	09-LB99-1
7	Ground (rollover)	00-RDAO-2

The roof of the vehicle was removed by the fire department during the extrication of the driver. This was accomplished by cutting the upper A-pillars, and the midline of the B- and C-pillars with hydraulic equipment. The doors of the vehicle were removed post-crash as the investigating officer interrogated the vehicle in search of the air bag control module. Fire department personnel used hydraulic equipment to pry open the left door and cut the hinges at the A-pillar. The right door opened during the crash event and was removed post-crash. The officer further noted that hydraulic spreaders were used to move the right lower A-pillar and sill forward, to provide access to the right seat area.

Interior

The interior of the Cobalt sustained severe damage that was associated with exterior deformation, passenger compartment intrusion, and driver contact. Maximum intrusion involved 95 cm (56.5”) of rearward displacement of the right corner of the mid instrument panel. The intrusions, magnitude, and direction are listed in the following table for the two front-seated positions.

Position	Component	Magnitude	Direction
Front Left	Toe pan	18 cm (56.5”)	Longitudinal
Front Left	Steering column	5 cm (2”)	Longitudinal
Front Left	Mid instrument panel	18 cm (7”)	Longitudinal
Front Right	Right corner mid instrument panel	95 cm (37.25”)	Longitudinal
Front Right	Right lower A-pillar	67 cm (45.75”)	Longitudinal

The steering wheel rotated upward as the cowl of the vehicle intruded rearward. The driver’s abdominal region loaded the lower aspect of the steering wheel rim. Her loading force fractured the mounting flange of the alloy wheel, thus resulting in complete separation of the steering wheel and air bag module from the column. This assembly was not with the vehicle at the time of the SCI inspection. The separated steering wheel was noted in an on-scene police image of the crash site. In addition to the flange fracture, the driver compressed the energy absorbing steering column as evidenced by 0.6 cm (0.25”) of left shear capsule separation and 2 cm (0.75”) of right capsule compression. **Figure 9** is overall view of the driver’s trajectory and contact points.



Figure 9. Driver trajectory and contact points.

The driver’s knees and lower legs impacted the knee bolster (**Figure 10**). Her left knee scuffed the bolster 15-22 cm (5.75-8.75”) inboard of the left edge of the bolster panel and 15-23 cm (5.75-9.25”) below the top edge of the plastic panel. The right knee contact was located 44-50 cm (17.25-19.75”) inboard of the left edge and 20-24 cm (8-9.5”) below the top edge. A fabric scuff from her right leg was noted to the left side of the mid instrument panel at its juncture with the center console. This triangular fabric transfer was 13 cm (5”) in



Figure 10. Driver contact to the knee bolster.

height and width.

The interior rear view mirror was fractured and separated from the windshield from probable driver contact. Blood and scuffmarks were present on the upper right instrument panel and front right air bag control module.

The driver probably contacted the console mounted shifter as she responded laterally right to the rollover event. The console and front seats were damaged and severely deformed post-event as the officer searched for the air bag control module.

Manual Safety Belt Systems

The Cobalt was equipped with 3-point manual lap and shoulder safety belt systems for the five designated seated positions. The driver and front right passenger systems consisted of continuous loop belt webbing with sliding latch plates fixed B-pillar mounted D-rings. The driver's belt retracted onto an Emergency Locking Retractor (ELR) while the front right retractor was switchable from the ELR to an Automatic Locking Retractor (ALR) mode. The driver's belt system did not yield evidence of any historical use and was not used by the driver during this crash. At the time of the SCI inspection, the belt system was retracted against the left B-pillar and was free of damage and occupant loading evidence. At rest within the vehicle, the driver was observed by the first responders as unrestrained and slumped against the right front door of the Cobalt.

The rear seat was equipped with three continuous loop belt systems with sliding latch plates and ELR/ALR retractors. There were no rear seat occupants within the vehicle at the time of the crash and the rear belt systems did yield evidence of historical use.

In addition to the manual belt systems, the Cobalt was equipped with LATCH anchors for the two outboard rear seat positions. There were no child safety seats installed in this vehicle.

Frontal Air Bag System

The Cobalt was equipped with dual stage frontal air bags for the driver and front right passenger positions. It should be noted that the driver was the sole occupant of this vehicle and that the frontal air bag system did not deploy as a result of the crash event.

The driver air bag was conventionally housed within the spokes of the steering wheel rim. The driver loaded the steering wheel rim and fractured the alloy steering wheel flange, thus separating the wheel/air bag assembly from the steering column. The steering wheel/air bag module was visible in an on-scene police image of the crash site; however, it was not with the vehicle at the time of the SCI inspection. Based on an exemplar vehicle, the air bag cover flaps were an I-configuration. The clockspring assembly was fractured from the wheel loading and was found spooled-out of the assembly.

The front right passenger air bag was concealed by a single forward hinged air bag module flap in the upper right aspect of the instrument panel. The cover flap was

displaced from the upper instrument panel by the severe intrusion of the right instrument panel. The air bag membrane and module assembly were not damaged or displaced. As part of the SCI inspection process into the non-deployed state of the driver's air bag system, the 10 amp fuse was located and checked for visible signs of failure. The fuse was located in the interior fuse box that was located under the right instrument panel. This fuse was removed from the appropriately marked position No. 13 and was found to be intact with no evidence of failure. The fuse was subsequently repositioned into the panel.

Event Data Recorder

The 2005 Colbalt was equipped with a sensing and diagnostic module (SDM) that performed the functions of crash sensing, air bag system fault detection, with Event Data Recorder (EDR) capabilities. The SDM was located in the floor of the center console aft of the transmission shifter. The EDR was downloaded through the Diagnostic Link Connector (DLC) using Vetronix software version 2.71.14 and the beta version interface box required for the "Can System" on select 2005 model year vehicles. Power was supplied by reconnecting the vehicle's battery, which maintained power.

The EDR recorded the following System Status at 1 Second of Algorithm Enable (AE):

- Transmission Range – Second gear
- Transmission Selector Position – Fourth gear
- Traction Control System Active – Yes
- Outside Air Temperature – 72.5 degrees F
- Left Front Door Status – Closed
- Right Front Door Status – Closed

The Pre-Crash Data highlights recorded by the EDR were as follows:

Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Vehicle Speed (mph)	53	57	62	65	69
Engine Speed (RPM)	4636	4992	5312	5568	6016
Percent Throttle	100	100	100	100	100
Accelerator Pedal Position	96	96	96	96	96
Antilock Brake System Active	No	No	No	No	No

A Single Non-Deployment Event was recorded for this crash sequence. Key data points recorded by the EDR at the non-deployment event were captured under the System Status at Non-Deployment table. These were recorded as follows:

- Ignition Cycles at Investigation – 465
- SIR Warning Lamp Status – Off
- SIR Warning Lamp ON/OFF Time (seconds) - 563220
- Number of Ignition Cycles SIR Warning lamp Was ON/OFF Continuously - 464
- Ignition Cycles at Event - 464
- Ignition Cycles Since DTCs were last Cleared - 158

Driver's Belt Circuit Status -	Unbuckled
Diagnostic Trouble Codes at Events 1-6 -	N/A
Maximum SDM Recorded Velocity Change (MPH) -	49.99
Algorithm Enable to Maximum	
Recorded Velocity Change (msec)-	300
Driver First Stage Deployment Loop Commanded -	No
Driver Second Stage Deployment Loop Commanded -	No
Multiple Event Counter -	1
An Event(s) Preceded Recorded Event(s) -	No
An Event(s) was in Between the Recorded Event(s) -	No
An Event(s) Followed the Recorded Event(s) -	Yes
The Event(s) Not recorded was a Deployment Event(s) -	No
The Event(s) Not Recorded was a Non-Deployment Event(s) -	Yes
Crash Record Locked -	No
Vehicle Event Data (Pre-Crash) Associated With This Event -	Yes
Deployment Event Recorded in the Non-Deployment Record -	No
Event Recording Complete -	Yes
Calculated Principle Direction of Force -	15

Summation of this Crash Event Based on the EDR Output

The 16-year old driver of the Chevrolet Cobalt was operating the vehicle unrestrained. She was traveling at full throttle as evidenced by the increase in engine RPM and the recorded vehicle speed throughout the five-second pre-crash intervals. The frontal air bag system was in a proper operating mode based on the internal diagnostic checks and the recording of no active faults. The air bag system did not deploy as the SDM recorded a gradual ramp-up of the x-axis acceleration. At 100 msec of AE, the recorded delta V along the x-axis was -8.7 km/h (-5.42 mph). The maximum delta V recorded was 80 km/h (49.99 mph) at the end of the recording cycle of 300 msec.

Another non-deployment event was detected by the SDM during this crash sequence, however, this SDM is limited to recording a single non-deployment event. This event occurred after this recorded non-deployment event. The EDR output is included as ***Attachment A*** of this report.

Occupant Demographics

Driver Age/Sex:	16 year old/Female
Height:	157 cm (62.0")
Weight:	48 kg (106.0 lb)
Eyewear:	None reported
Seat Track Position:	Forward track position
Manual Safety Belt Use:	None
Usage Source:	Vehicle inspection, EDR output
Egress from Vehicle:	Removed by rescue personnel
Mode of Transport	
From Scene:	Transported by ambulance to a local hospital

Type of Medical Treatment: Arrived pulseless, CPR in progress, intubated on arrival, resuscitation efforts failed and the driver was pronounced deceased 46 minutes following arrival.

Driver Injuries

Injury	Injury Severity AIS 90/Update 98	Injury Source
Multiple lacerations of the right lobe of the liver with involvement of the hepatic capsule and hemoperitoneum; two liters of partially clotted blood were noted in the abdominal cavity	Severe (541826.4,1)	Steering wheel
Abrasion over the right eye (1.5x.75")	Minor (290202.1,1)	Rear view mirror
Contusion of the right upper lip (0.5x0.5")	Minor (290402.1,8)	Right upper instrument panel
Contusion of the right chin (0.5x0.5")	Minor (290402.1,1)	Right upper instrument panel
2.5 cm (1.0") laceration of the right eyelid w/surrounding contusion	Minor (297602.1,1; 297402.1,1)	Rear view mirror
Multiple contusions of the antero-lateral right thigh	Minor (890402.1,1)	Center console/transmission selector
Multiple contusions over the knees bilaterally	Minor (890402.1,3)	Knee bolster
Contusion of the anterior right thigh	Minor (890402.1,1)	Center console/transmission selector
Abrasion over the right anterior lower leg (0.25x0.25")	Minor (890202.1,1)	Knee bolster and below

Source – Autopsy Report

Driver Kinematics

The 16-year old female driver of the 2005 Cobalt was seated in a presumed upright attitude with the seat track adjusted to a forward position. She was not restrained by the manual 3-point lap and shoulder belt system. The lack of belt usage was supported by the post-crash position and condition of the safety belt webbing. The belt system was retracted and stowed against the left B-pillar and was void of historical use and crash related loading evidence. Additionally, the driver's trajectory and subsequent contact points were consistent with those of an unrestrained occupant, and the driver was found slumped against the right door, unrestrained by the first responders.

The initial impact with the small diameter tree minimally displaced the driver forward as the vehicle displaced and overrode the tree. This impact did not alter the trajectory of the vehicle. The Cobalt continued forward in a tracking attitude and struck the large diameter tree with the front right area. The resultant crush produced intrusion of the frontal components and rotated the steering column vertically upward.

The unrestrained driver initiated a forward trajectory in response to the frontal crash forces by moving on a straight-line trajectory, relatively parallel to the ground. Her knees contacted and scuffed the plastic knee bolster panel on each side of the steering column. Her right knee also contacted and scuffed the mid instrument panel at the junction of the center console. As a result of the knee bolster contacts, the driver sustained bilateral knee contusions and an abrasion over the right anterior (lower) leg.

The continued forward trajectory of the driver resulted in her abdomen loading the lower edge of the steering wheel rim. Due to the vertical displacement of the column, her abdomen loaded the edge of the wheel rim. As the rim engaged the soft, non-structural abdominal wall, the driver's chest probably wrapped onto the non-deployed air bag module and upper wheel rim. The abdominal loading resulted in multiple lacerations of the right lobe of the liver with involvement of the hepatic capsule and hemoperitoneum. The driver's loading of the steering assembly deformed the rim and fractured the mounting flange, separating the wheel and air bag module from the column. As previously noted, the separated steering wheel assembly was not with the Cobalt at the time of the SCI inspection. The driver's loading force was transmitted into the steering column. This was evidenced by 0.6 cm (0.25") of left shear capsule compression and 2 cm (0.75") on the right side.

As the Cobalt crushed to maximum engagement, the vehicle traveled past the struck tree and rotated in a clockwise direction, engaged four small diameter trees and overturned onto its right side. The unrestrained driver moved laterally across the interior of the vehicle. Her right thigh contacted the center console resulting in multiple soft tissue contusions of the antero-lateral right thigh. The driver's head probably contacted the interior mounted rear view mirror, which produced an abrasion over the right eye and a laceration of the right eyelid with a surrounding contusion.

The driver continued on a downward trajectory toward the right door as the vehicle rolled onto its right side. Her chin and upper lip contacted the upper right instrument panel, which resulted in the contusions of the lip and chin.

She came to rest slumped against the right door as the vehicle came to rest on its right side. Her legs were reportedly extended across the console in an elevated position with her feet captured between the intruding lower left instrument panel and the driver's seat cushion. In this position, the contortion of her body limited the blood flow from the liver lacerations and the driver remained in a conscious state.

Medical Treatment

Rescue personnel found the driver in this position as they arrived on-scene and were conversing with her while initial treatment was administered. As she was moved from her final rest position within the vehicle, the driver coded and became unconscious. CPR was administered as she was transported by ambulance to a local hospital, arriving approximately one hour following the time of the crash. On arrival, she was pulseless and non-intubated. The attending emergency room physician immediately intubated her and an IV was initiated. Resuscitation efforts failed to return a pulse and she was pronounced deceased 46 minutes following arrival, 1.75 hours following the crash. An autopsy was performed on the body on the day of the crash.

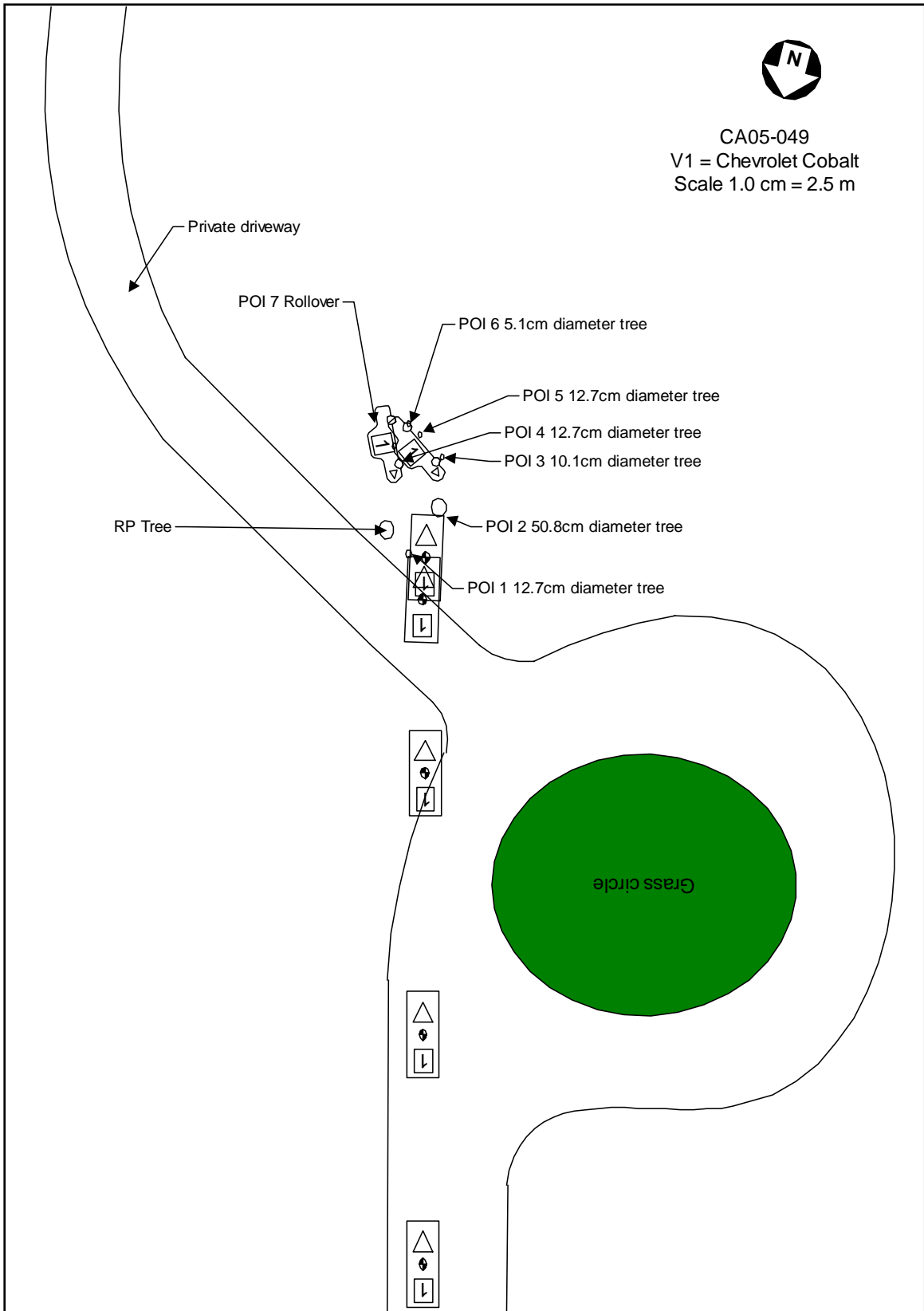


Figure 11: Scene Schematic

CDR File Information

Vehicle Identification Number	1G1AL12F857*****
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	IYT.CDR
Saved on	Friday, August 26 2005 at 12:20:11 PM
Collected with CDR version	Crash Data Retrieval Tool 2.7114
Collecting program verification number	6612B7BD
Reported with CDR version	Crash Data Retrieval Tool 2.800
Reporting program verification number	9238B95E
Interface used to collected data	Block number: 00 Interface version: 44 Date: 07-18-05 Checksum: 2E00
Event(s) recovered	Non-Deployment

SDM Data Limitations

SDM Recorded Crash Events:

There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It can contain 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 can contain 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 cannot 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 Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event unless a Deployment Level Event occurs within 5 seconds after the Deployment Event, then the Deployment Level Event will overwrite the Non-Deployment Event file.

SDM Data Limitations:

-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 Deployment Events and Deployment Level Events, the SDM will record 220 milliseconds of data after deployment criteria is met and up to 70 milliseconds before deployment criteria is met. For Non-Deployment Events, the SDM will record up to the first 300 milliseconds of data after algorithm enable. The minimum SDM Recorded Vehicle Forward Velocity Change, that is needed to record a Non-Deployment Event, is 5 MPH.

-Maximum Recorded Vehicle Velocity Change is the maximum recorded velocity change in the vehicle's combined "X" and "Y" axis.

-Calculated Principal Direction of Force (PDOF) is the arctangent of the maximum observed lateral velocity change divided by the maximum observed longitudinal velocity change. PDOF is displayed where zero degrees is located at the front of the vehicle, with 90 degrees is displayed to the right side of the vehicle and so on, clockwise around the vehicle.

-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 receive an invalid message from the module sending the pre-crash data.

-Driver's and Passenger's Belt Switch Circuit Status indicates the status of the seat belt switch circuit. The Passenger Belt Switch Circuit Status for 2006 Chevrolet Cobalt Sport Coupe (AP) model vehicles, with the option package that includes Recaro brand seats (RPO ALV), will always report a default value of "Buckled".

-The Time Between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than 5 seconds, "N/A" is displayed in place of the time. If the value is negative, then the Deployment Event occurred first. If the value is positive, then the Non-Deployment Event occurred first.

-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.

-The ignition cycle counter relies upon the transitions through OFF->RUN->CRANK power-moding messages, on the GMLAN communication bus, to increment the counter. Applying and removing of battery power to the module will not increment the ignition counter.

SDM Data Source:

1G1AL12F857*****

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

- Vehicle Status Data (Pre-Crash) is transmitted to the SDM, by various vehicle control modules, via the vehicle's communication network.
- The Belt Switch Circuit is wired directly to the SDM.

System Status At AE

Vehicle Identification Number	**1AL12F*5*****
Low Tire Pressure Warning Lamp (If Equipped)	OFF
Vehicle Power Mode Status	Accessory
Remote Start Status (If Equipped)	Inactive
Run/Crank Ignition Switch Logic Level	Active
Brake System Warning Lamp (If Equipped)	OFF

System Status At 1 second

Transmission Range (If Equipped)	Second Gear
Transmission Selector Position (If Equipped)	Fourth Gear
Traction Control System Active (If Equipped)	Yes
Service Engine Soon (Non-Emission Related) Lamp	OFF
Service Vehicle Soon Lamp	OFF
Outside Air Temperature (degrees F) (If Equipped)	72.5
Left Front Door Status (If Equipped)	Closed
Right Front Door Status (If Equipped)	Closed
Left Rear Door Status (If Equipped)	Unused
Right Rear Door Status (If Equipped)	Unused
Rear Door(s) Status (If Equipped)	Closed

Pre-crash data

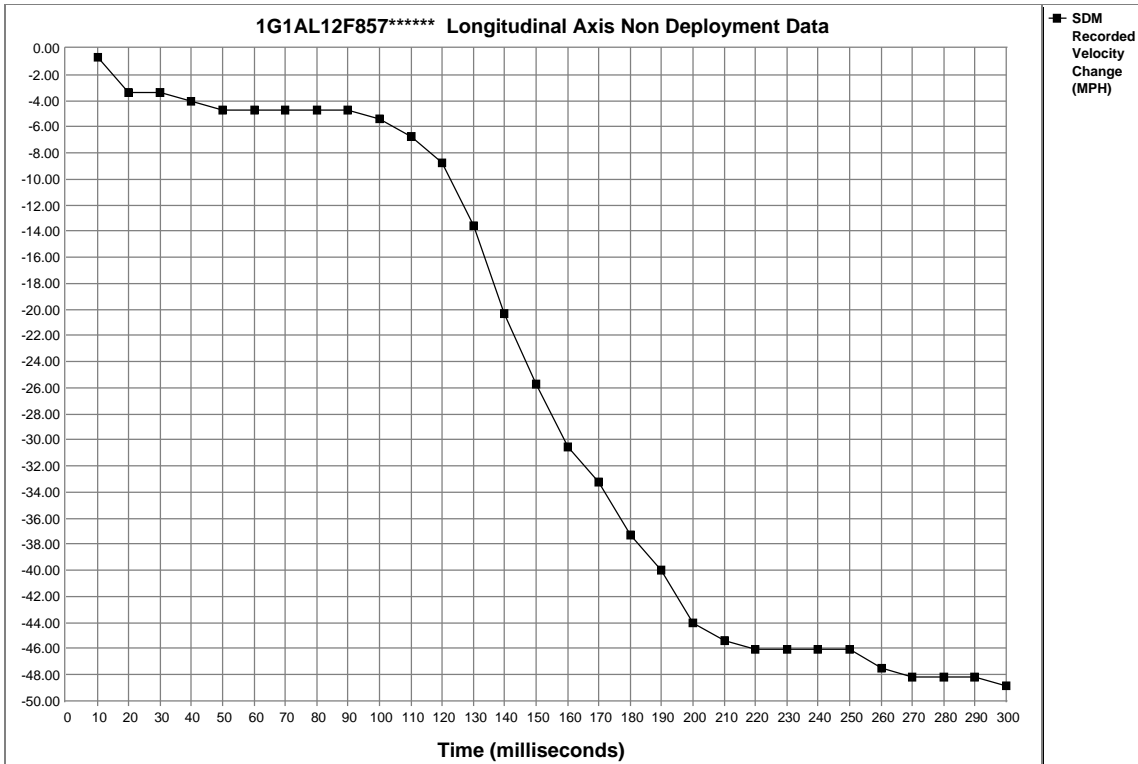
Parameter	-2 sec	-1 sec
Reduced Engine Power Mode	OFF	OFF
Cruise Control Active (If Equipped)	No	No
Cruise Control Resume Switch Active (If Equipped)	No	No
Cruise Control Set Switch Active (If Equipped)	No	No

Pre-crash data

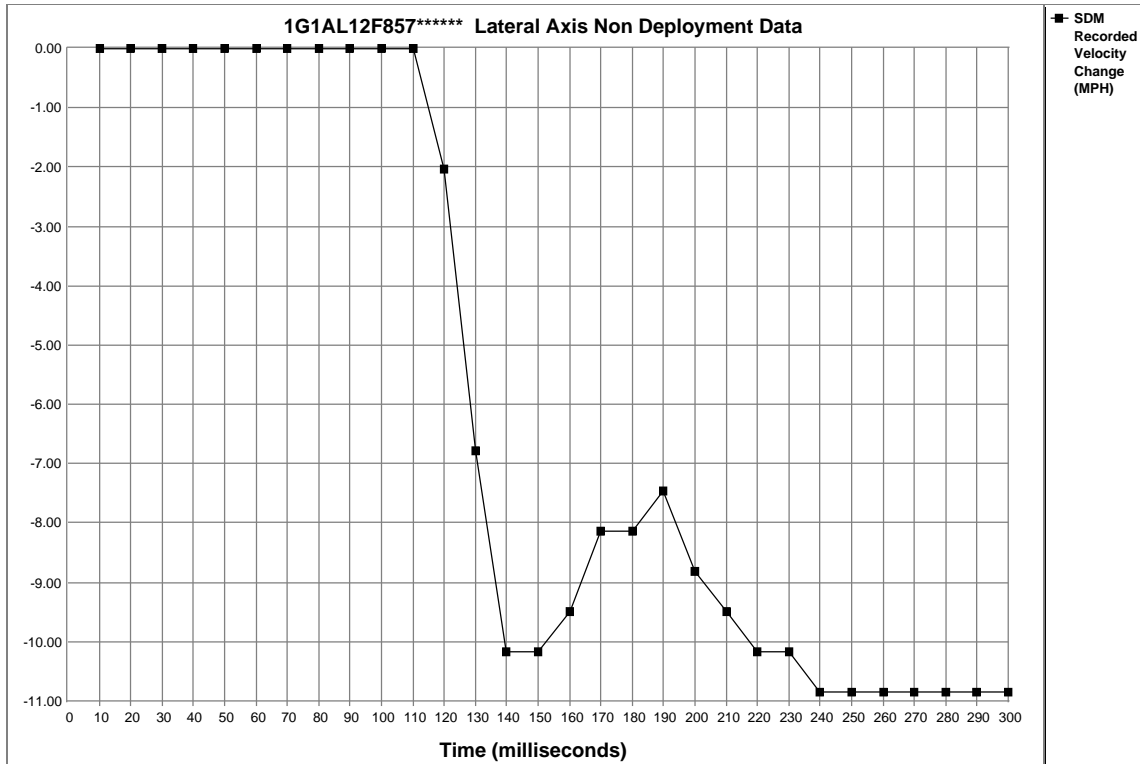
Parameter	-5 sec	-4 sec	-3 sec	-2 sec	-1 sec
Vehicle Speed (MPH)	53	57	62	65	69
Engine Speed (RPM)	4736	4992	5312	5568	6016
Percent Throttle	100	100	100	100	100
Accelerator Pedal Position (percent)	96	96	96	96	96
Antilock Brake System Active (If Equipped)	No	No	No	No	No
Lateral Acceleration (feet/s ²)(If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid
Yaw Rate (degrees per second) (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid
Steering Wheel Angle (degrees) (If Equipped)	0	0	0	0	0
Vehicle Dynamics Control Active (If Equipped)	Invalid	Invalid	Invalid	Invalid	Invalid

System Status At Non-Deployment

Ignition Cycles At Investigation	465
SIR Warning Lamp Status	OFF
SIR Warning Lamp ON/OFF Time (seconds)	563220
Number of Ignition Cycles SIR Warning Lamp was ON/OFF Continuously	464
Ignition Cycles At Event	465
Ignition Cycles Since DTCs Were Last Cleared	158
Driver's Belt Switch Circuit Status	UNBUCKLED
Diagnostic Trouble Codes at Event, fault number: 1	N/A
Diagnostic Trouble Codes at Event, fault number: 2	N/A
Diagnostic Trouble Codes at Event, fault number: 3	N/A
Diagnostic Trouble Codes at Event, fault number: 4	N/A
Diagnostic Trouble Codes at Event, fault number: 5	N/A
Diagnostic Trouble Codes at Event, fault number: 6	N/A
Maximum SDM Recorded Velocity Change (MPH)	49.99
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	300
Driver First Stage Deployment Loop Commanded	No
Driver Second Stage Deployment Loop Commanded	No
Driver Side Deployment Loop Commanded	No
Driver Pretensioner Deployment Loop Commanded	No
Driver (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Driver (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Driver Knee Deployment Loop Commanded	No
Passenger First Stage Deployment Loop Commanded	No
Passenger Second Stage Deployment Loop Commanded	No
Passenger Side Deployment Loop Commanded	No
Passenger Pretensioner Deployment Loop Commanded	No
Passenger (Initiator 1) Roof Rail/Head Curtain Loop Commanded	No
Passenger (Initiator 2) Roof Rail/Head Curtain Loop Commanded	No
Passenger Knee Deployment Loop Commanded	No
Second Row Left Side Deployment Loop Commanded	No
Second Row Left Pretensioner Deployment Loop Commanded	No
Third Row Left Roof Rail/Head Curtain Loop Commanded	No
Second Row Right Side Deployment Loop Commanded	No
Second Row Right Pretensioner Deployment Loop Commanded	No
Third Row Right Roof Rail/Head Curtain Loop Commanded	No
Second Row Center Pretensioner Deployment Loop Commanded	No
Multiple Event Counter	1
An Event(s) Preceded the Recorded Event(s)	No
An Event(s) was in Between the Recorded Event(s)	No
An Event(s) Followed the Recorded Event(s)	Yes
The Event(s) Not Recorded was a Deployment Event(s)	No
The Event(s) Not Recorded was a Non-Deployment Event(s)	Yes
Crash Record Locked	No
Vehicle Event Data (Pre-Crash) Associated With This Event	Yes
Deployment Event Recorded in the Non-Deployment Record	No
Event Recording Complete	Yes
Estimated Principal Direction of Force (PDOF) degrees	15



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Longitudinal Axis Recorded Velocity	-0.68	-3.39	-3.39	-4.07	-4.74	-4.74	-4.74	-4.74	-4.74	-5.42	-6.78	-8.81	-13.56	-20.34	-25.76
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Longitudinal Axis Recorded Velocity	-30.50	-33.21	-37.28	-39.99	-44.06	-45.42	-46.09	-46.09	-46.09	-46.09	-47.45	-48.13	-48.13	-48.13	-48.80



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Lateral Axis 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	-2.03	-6.78	-10.17	-10.17
Time (milliseconds)	160	170	180	190	200	210	220	230	240	250	260	270	280	290	300
Lateral Axis Recorded Velocity Change (MPH)	-9.49	-8.13	-8.13	-7.46	-8.81	-9.49	-10.17	-10.17	-10.85	-10.85	-10.85	-10.85	-10.85	-10.85	-10.85

Hexadecimal Data

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

```
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$02 00 00 00 00 00 00 00
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$04 02 00 00 00 00 00 00
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$06 00 4A 00 00 19 94 32
$07 14 C9 00 00 00 00 00
$08 00 FF 00 00 00 00 00
$09 00 85 85 00 00 00 00
$0A 00 00 00 00 00 00 00
$0B 00 00 01 0F 01 00 00
$0C 00 00 00 00 00 00 00
$0D 00 00 40 00 00 00 00
$0E 40 00 00 00 00 00 00
$0F BA 00 00 00 00 00 00
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$11 38 35 37 35 39 35 34
$12 31 36 00 00 00 00 00
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$4D F5 C5 F3 BF F2 BD 00
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$7B FF FF FF FF FF FF 00

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$41 3F 00 00 02 00 18
$42 10 C4
$43 00 00 8C 80
```

```
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$47 0A 64 02 04 04 05 0A 06 04 0A 00 00 FA 00 00 FF 04 64
$48 18 08 08
$B0 58
$B1 FD FE 00
$B2 FF FF FF FF FF
$B4 41 53 39 34 33 32 32 33 32 32 33 51 20 20 20 20
$B7 50 AA 01 0F 01
$B8 54 41 68 04 02
$C1 30 46 30 31
$CA 30 46 30 31
$CB 00 E8 B0 18
$CC 00 E8 B0 18
$D1 00 00
$DB 00 00
$DC 00 00
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