CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE ADAPTIVE CONTROL VEHICLE CRASH INVESTIGATION

CASE NO: CA05-037

VEHICLE: 2005 CHEVROLET VENTURE MINIVAN

LOCATION: MICHIGAN

CRASH DATE: MARCH 2005

Contract No. DTNH22-01-C-17002

Prepared for:

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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

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16. Abstract This on-site investigation focused on the severity of the crash, the type of adaptive equipment that was installed in the vehicle to meet the requirements of the physically challenged driver and the performance of the frontal air bag system. The crash involved a 2005 Chevrolet Venture minivan that was equipped with a lowered floor, a wheel chair ramp and primary and secondary adaptive driving equipment manufactured by Electronic Mobility Controls (EMC). The 50-year old female driver of the Venture minivan crossed into the opposing travel lanes on a divided highway and struck a 2000 Ford Windstar in a head-on configuration. The impact resulted in severe damage to both vehicles and deployed their frontal air bag systems. Both drivers sustained massive trauma and expired at the scene of the crash. As a result of her involvement with the intruding steering assembly, the driver of the Venture sustained multiple lacerations of the liver, transaction of the pancreas, laceration of the descending aorta, multiple bilateral rib fractures, a sternum fracture, and pulmonary contusion hemorrhages. The two child passengers restrained in forward child safety seats in the second row of the Ford Windstar sustained incapacitating injuries. They were transported and admitted to a regional trauma center for treatment of their injuries.			
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BACKGROUND

This on-site investigation focused on the severity of the crash, the type of adaptive equipment that was installed in the vehicle to meet the requirements of the physically challenged driver and the performance of the frontal air bag system. The crash involved a 2005 Chevrolet Venture minivan that was equipped with a lowered floor, a wheel chair ramp and primary and secondary adaptive driving equipment manufactured by Electronic Mobility Controls (EMC). The 50-year old female driver of the Venture minivan crossed into the opposing travel lanes on a divided highway and struck a 2000 Ford Windstar in a head-on configuration. The impact resulted in severe damage to both vehicles and deployed their frontal air bag systems. Both drivers sustained massive trauma and expired at the scene of the crash. As a result of her involvement with the intruding steering assembly, the driver of the Venture sustained multiple lacerations of the liver, transaction of the pancreas, laceration of the descending aorta, multiple bilateral rib fractures, a sternum fracture, and pulmonary contusion hemorrhages. The two child passengers restrained in forward child safety seats in the second row of the Ford Windstar sustained incapacitating injuries. They were transported and admitted to a regional trauma center for treatment of their injuries. **Figure 1** is a frontal view of the damage to the 2005 Chevrolet Venture.

Figure 1. Severe frontal damage to the 2005 Chevrolet Venture adaptive control minivan.

The investigating officer notified the National Highway Traffic Safety Administration of the March 2005 crash on June 8, 2005. He initially reported a potential safety defect that involved the relocation of the air bag control module in the Chevrolet Venture. The case was assigned to the Calspan Special Crash Investigations (SCI) team for on-site investigation on the date of the NHTSA notification. Both vehicles were released from police impound and transferred to regional insurance salvage yards where they were located for SCI inspection. The on-site aspect of this investigation was conducted on June 29-30, 2005.

SUMMARY

Crash Site

The crash occurred on a divided highway in a rural area during nighttime hours. The roadway consisted of two travel lanes in each direction that was separated by an 8 m (26.2') wide depressed grass median **(Figure 2)**. The outboard travel lanes were 3.8 m

(12.4') in width while the inboard lanes measured 3.4 m (11.2') in width. The asphalt surfaced travel lanes were bordered by 2.9 m (9.5') wide outboard shoulders and 1.6 m (5.2') wide inboard shoulders. Tactile warning devices (rumble strips) were cut into the four asphalt shoulders. In the vicinity of the crash site, the roadway was straight with a slight positive grade to the north. At the time of the crash, the light conditions were dark and the surfaces were dry. The temperature was police reported as 7 degrees C (46 degrees F). The posted speed limit was 113 km/h (70 mph). There was no physical evidence remaining at the crash site when inspected for this SCI effort. The Crash Schematic is attached as **Figure 15** of this narrative report.

Figure 2. Northbound view of the crash site and the Venture's point of departure.

Vehicle Data

2005 Chevrolet Venture

The 2005 Chevrolet Venture LS was a four-door extended (long wheelbase) minivan, with a rear lift gate. The vehicle was identified by the Vehicle Identification Number (VIN): 1GBDV13E35D (production number omitted). The vehicle was powered by a transverse mounted 3.4 liter V-6 engine linked to a four-speed automatic transmission. The service brakes were four-wheel disc with anti-lock (ABS). The Gross Vehicle Weight Rating (GVWR) was 2,430 kg (5,357 lb) split evenly at 1,250 kg (2,455) front and rear. The minivan was equipped with multi-spoke alloy wheels and General XP2000 GT all-season tires, size P215/70R15. The manufacturer recommended tire pressure was 240 kPa (35 PSI) for both axles. The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	0 kPa	8 mm (10/32")	Tire sidewall cut, outer bead of wheel dented
Left Rear	207 kPa (30 PSI)	9 mm (11/32")	None
Right Front	207 kPa (30 PSI)	8 mm (10/32")	None
Right Rear	248 kPa (36 PSI)	9 mm (11/32")	None

The interior of the Chevrolet was extensively altered from OEM due to the installation of the adaptive equipment. These are addressed in detail in the ***Adaptive Control*** section of this report. A lowered floor was added to the vehicle which extended from the front toe pan to aft of the C-pillars, ending at the base of the third row seat. A bi-fold wheelchair ramp was installed between the right B-and C-pillars. The OEM front seats were mounted to a power seat base that provided vertical height adjustment through a scissors-type mechanism and 90 degrees of swivel for transfer to and from a wheelchair. There was no second row seat in this vehicle. The OEM third seat remained in position in this van. The OEM manual restraint systems remained in place. These are addressed in the

Manual Safety Belt section of this report. It should be noted that this vehicle was equipped with OnStar; however, it was unknown if OnStar provided notification of the crash to the emergency notification system (911).

2000 Ford Windstar

The struck vehicle in this crash was a 2000 Ford Windstar LX four-door minivan. The Windstar was manufactured on November, 1999 and was identified by Vehicle Identification Number (VIN) 2FMZA5146YB (production number deleted). The vehicle was powered by a 3.8 liter transverse mounted V-6 engine linked to a four-speed automatic transmission. The service brakes were power-assisted front disc/rear drum. The Windstar was equipped with OEM multi-spoke alloy wheels with Goodyear Integrity front tires and Primera A/S Touring Radial all-season tires on the rear. All tires were sized at P215/70R15. The manufacturer recommended tire pressure for this vehicle was placarded at 241 kPa (35 PSI). The following table identifies the tire specific data at the time if the SCI inspection.

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	0 kPa	6 mm (7/32”)	Cut sidewall
Left Rear	221 kPa (32 PSI)	6 mm (8/32”)	None
Right Front	221 kPa (32 PSI)	6 mm (8/32”)	None
Right Rear	221 kPa (32 PSI)	6 mm (8/32”)	None

Adaptive Equipment – 2005 Chevrolet Venture

The 2005 Chevrolet Venture minivan had undergone extensive post-manufacturer modifications to meet the needs of the physically challenged 50-year old female driver. The Braun Corporation installed the droop floor that extended longitudinally from the toe pan to aft of the C-pillars and full width laterally. This modification involved the relocation of the frontal air bag control module. This is addressed in further detail under the ***Event Data Recorder*** section of this report. A bi-fold wheel chair ramp was installed at the right sliding door area. The OEM front bucket seats were mounted to a base with electrically controlled swivel and height adjustment. This base accommodated the driver to easily transfer from the motorized wheelchair to the driver’s position. The OEM 3-point safety belt system remained intact with the buckle assembly mounted to the inboard aspect of this base unit.

The interior adaptive driving equipment was installed by Clock Conversions of Grand Rapids, Michigan. This equipment was manufactured by Electronic Mobility Controls. The AEVIT line of electronically controlled adaptive equipment was installed and included a left side rigid stalk mounted throttle and brake controller. This unit was identified as the AEVIT DL-001. A T-handle extended from the controller which provided the driver with zero effort braking and throttle input. Additionally, this unit could be programmed to perform additional driving functions such as turn signals by clicking the T-handle laterally. It was unknown if any of these functions were programmed into this unit. This T-handle was fractured during the crash and the unit was separated from the mounting platform **(Figure 3)**.

A remote zero-effort steering system **(Figure 4)** was stalk mounted at the center of the vehicle. This unit was removed during the police inspection of the vehicle. This unit consisted of a 15 cm (6") diameter steering wheel mounted to the control box which measured 12x19 cm (4.8x7.4") by 7 cm (2.75") in depth. A 5 cm (1.9") diameter steering knob was mounted to the perimeter of the remote steering wheel. This steering unit was identified by AEVIT DW-001, Serial No. DW-001.

Figure 3. Adaptive throttle and brake hand control, separated from mount.

Figure 4, Remote steering unit.

A toggle-switch panel was found on the center floor of the vehicle. This was apparently mounted on the remote steering stalk. The unit controlled the swivel, tilt and slide functions for the driver's seat. A touch pad for the HVAC controls was found on the top center instrument panel. This touch pad contained seven functions. A second touch pad unit was mounted on a rigid stalk at the centerline of the vehicle. This unit was identified by Serial No.02002 and provided readouts through an information center display located at the top of the unit. Scroll pads, a function/select pad and an OFF pad completed the controls of this unit.

Mounted to the center front lowered floor area of the vehicle was an AEVIT Drive Module that applied brake and throttle functions. These separate units were identified as GAS/BRAKE 10R-020071 and STEERING 10R-020073. The AEVIT system central processing unit (CPU) was mounted to this bracket. It was identified as Digitpad II Gold Series. This CPU measured 29x20x4 cm (11.6x7.9x1.6").

A Quickie 2 motorized wheelchair was stowed in the second seat area of the vehicle at the time of the crash. It was unknown if this chair was secured to the vehicle, or loose between the front seats. It had been removed at the scene of the crash and placed back in the vehicle prior to the SCI investigation. The chair was found upside-down in the vehicle. No distinct damage was noted to the chair. This was not occupied by the driver at the time of the crash.

Crash Sequence

Pre-Crash

The driver of the 2005 Chevrolet Venture minivan was traveling in a northerly direction on an unknown lane on the divided highway. The EDR output recorded a pre-crash travel speed of 100 km/h (62 mph) at the five second interval prior to Algorithm Enable (AE). For unknown reasons, the driver of the Chevrolet relinquished control of the vehicle. The Venture traversed the depressed grass median and crossed into the southbound travel lanes **(Figure 5)**. The EDR data indicated that the driver increased throttle input at the -3 and -2 second intervals prior to AE and applied a braking input at -2 and -1 seconds of AE. Her travel speed was recorded at 87 km/h (54 mph) at the -1 second interval. Based on the minimal level of deceleration, the applied braking force was not excessive.

Figure 5. Chevrolet Venture's trajectory into the southbound travel lanes.

The driver of the 2000 Ford Windstar minivan was traveling in a southerly direction on the outboard lane of the divided highway as she approached the impending crash site. There was no physical evidence at the scene to indicate avoidance actions by the driver of the Ford.

Crash

The Chevrolet Venture impacted the Ford Windstar in a head-on configuration in the outboard southbound lane. The initial impact was offset left for both vehicles; however, due to the severity of the crash, the full frontal areas sustained direct contact damage during engagement. The resultant directions of force were within the 12 o'clock sector for both vehicles. The damage algorithm of the WINSMASH program computed velocity changes of 98 km/h (60.8 mph) for the Chevrolet and 112 km/h (69.6 mph) for the Ford Windstar. The specific longitudinal and lateral components were -92 km/h (-57.2 mph) and -34 km/h (-20.8 mph) for the Venture and -110 km/h (-68.5 mph) and 19 km/h (12.1 mph) for the Windstar. The EDR data from the Venture minivan recorded a longitudinal velocity change of 32 km/h (19.8 mph). Based on the severity of the damage, the EDR-recorded value is extremely under reported.

The frontal air bag systems in both vehicles deployed. The EDR data recorded a Stage 2 deployment for the frontal air bags in the Chevrolet Venture. The deployment was commanded at 7.5 ms of AE.

Following engagement, the vehicles separated and traveled on their respective post-crash trajectories. The Chevrolet Venture rotated approximately 110 degrees counterclockwise before coming to rest

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

perpendicular across the outboard southbound travel lane. The Windstar was deflected off the west road edge and came to rest beyond the shoulder, facing in an easterly direction. Based on its final rest position, the Ford rotated approximately 90 degrees counterclockwise. Both vehicles came to rest near the initial point of impact **(Figure 6)**.

Post-Crash

The driver expired at the scene of the crash and were pronounced deceased by the County Coroner. The child passengers of the Ford Windstar were removed from the vehicle by rescue personnel and transported to a regional trauma center where they were admitted for treatment of their injuries.

Vehicle Damage

Exterior – 2005 Chevrolet Venture

The adaptive control 2005 Chevrolet Venture minivan sustained severe frontal damage as a result of the head-on crash with the Ford Windstar. The direct contact damage extended full width across the vehicle and measured 171 cm (67.5") along the level of the upper radiator support. The bumper fascia was fractured and separated from the vehicle. Maximum crush was located at the left corner of the front bumper beam and measured 145 cm (57.1"). The bumper beam was crushed rearward and displaced right resulting in a combined direct and induced damage width (Field L) of 104 cm (41"). The crush profile at the level of the bumper beam was as follows: C1 = 145 cm (57.1"), C2 = 139 cm (54.6"), C3 = 126 cm (49.5"), C4 = 100 cm (39.5"), C5 = 84 cm ((33"0, C6 = 67 cm (26.25"). **Figure 7** is an overhead view of the frontal crush profile. The Collision Deformation Classification (CDC) for this impact event was 12-FDEW-6.

The impact resulted in severe frontal intrusion **(Figure 8)** of the interior and induced deformation of both side surfaces of the vehicle. The left front door opened due to rearward displacement of the left A-pillar and stress overload of the door latch. The latch released and the door opened during the crash. The lower door hinge was separated by damage. The left rear sliding door opened during the crash due to pillar displacement. The longitudinal distance between the left B- and C-pillars was 77 cm (30.5"). The sliding door, although damaged, was 112 cm (44") in length post-crash. The rear lift gate remained closed and operational post-crash. The right front door remained closed during the crash. It appeared to have been forced open by rescue personnel. Due to body displacement, the door would not re-latch. The right rear sliding door was jammed closed.

Figure 7. Overhead view depicting the extend of frontal crush.

Figure 8. Compression of the frontal structure and of the driver's compartment.

Rescue personnel used hydraulic equipment to cut the upper left A-, B-, and C-pillars and the right upper A- and B-pillars, plus the window frame of the right sliding door. The roof was deflected back at the C-pillars to remove the driver's body from the vehicle.

Interior – 2005 Chevrolet Venture

The interior of the Chevrolet Venture adaptive control minivan sustained severe damage as a result of the frontal deformation and resulting intrusion. Additionally, the safety belted driver loaded through the deployed driver's air bag and engaged the intruding steering assembly. Her loading of the steering assembly deformed the upper wheel rim **(Figure 9)** 13 cm (5") and compressed the energy absorbing column. This was verified by complete separation of the shear brackets. The sub instrument panel structure that the shear capsule blocks were mounted to was rotated vertically to a measured angle of 82 degrees. The front right seat and several components of the adaptive driving equipment were removed during the police inspection of the vehicle in search of the air bag control module. The interior intrusions are detailed in the following table.

Figure 9. Deformed upper steering wheel rim.

Vehicle Position	Intruding Component	Direction	Magnitude
Front Left	Left A-Pillar	Rearward	53 cm (21")
Front Left	Left Toe Pan	Rearward	64 cm (25")
Front Left	Steering Wheel/Column	Rearward	43 cm (17")
Front Left	Left Instrument Panel	Rearward	46 cm (18")
Front Left	Roof/Left Side rail	Vertical (down)	37 cm (14.5")
Front Left	Driver's Seat	Vertical (up)	25 cm (10")
Front Right	Right Toe pan	Rearward	33 cm (13")
Front Right	Right Instrument panel	Rearward	15 cm (6")
Front Right	Right Roof	Vertical	22 cm (8.5")

Exterior – 2000 Ford Windstar

The Ford Windstar sustained severe frontal damage **(Figure 10)** as a result of the head-on crash with the Chevrolet Venture minivan. Maximum crush was measured at 148 cm (58.4") at the left corner of the upper radiator support and 139 cm (54.6") at the left corner of the bumper beam. The direct contact damage began at the right corner of the hood and extended 147 cm (58") to the left corner. The Ford's bumper fascia was separated by the impact and was not with the vehicle. (A Pontiac bumper fascia of another color was placed in the passenger compartment of this vehicle.) This fascia was not related to this crash. The impact severely crushed the frontal structure of the van. The left corner area was displaced rearward which deflected the right corner area of the Windstar laterally left. Two levels of measurements were documented for the frontal crush profile **(Figure 11)**; one at the level of the bumper beam and the second at the level of the upper radiator support. The bumper beam was crushed and displaced left which

resulted in a combined induced and direct contact damage length (Field L) measurement of 43 cm (17”). Four equidistant crush values were documented along this plane and were as follows: C1 = 139 cm (54.6”), C2 = 123 cm (48.5”) C3 = 98 cm (38.5”), C4 = 31 cm (12.2). These measurements reflect deductions made for bumper contour and the thickness of the energy absorbing foam. The crush profile at the level of the upper radiator support was measured along a Field L of 91 cm (36”). The profile was as follows: C1 = 148 cm (58.4”), C2 = 133 cm (52.3”), C3 = 114 cm (44.8”), C4 = 95 cm (37.25”), C5 = 57 cm (22.3”), C6 = 31 cm (12.1”). The CDC for this impact was 12-FDEW-6.

Figure 10. Frontal view of the damage to the Ford Windstar.

Figure 11. Lateral view of the Windstar’s frontal crush profile.

Frontal Air Bag System – 2005 Chevrolet Venture

The Chevrolet Venture was equipped with dual stage frontal air bags for the driver and front right passenger positions. Both air bags deployed as a result of the severe frontal crash. The EDR output recorded Stage 2 deployments commanded at 7.5 ms of AE.

The driver air bag was conventionally mounted within the steering wheel and concealed by two I-configuration module cover flaps. The symmetrical cover flaps were 10 cm (3.75”) in width and 11 cm (4.4”) in height at the vertical tear seam. The air bag membrane was approximately 61 cm (24”) in diameter in its deflated state and was tethered by two internal straps at he 3 and 9 o clock positions. The air bag was vented by two 2 cm (0.75”) diameter vents at the top forward panel of the bag. The driver air bag was torn on the left side adjacent to the module assembly **(Figure 12)**. The air bag did not yield driver loading/contact evidence at the time of the SCI inspection.

Figure 12. Tear of the driver’s air bag.

The front right air bag deployed from a top-mount module that was concealed by a single cover flap that measured 20 cm (8”) in depth and 39 cm (15”) in width. The air bag was

tethered by a single wide band tether that was sewn to the face of the bag. Two 3 cm (1.1") diameter vent ports vented the bag at the 3 and 9 o'clock sectors.

The Venture was equipped with seat back mounted side impact air bags. These side impact air bags did not deploy during this severe frontal crash event.

Event Data Recorder – 2005 Chevrolet Venture

The Chevrolet Venture's frontal air bag system was controlled by a single point Sensing and Diagnostic control Module (SDM) that also had Event Data Recording (EDR) capabilities. The SDM was originally mounted at the factory to the floor of the vehicle under the front right seat. The van modifier that installed the lowered floor repositioned the SDM to the forward center aspect of the lowered floor. A fabricated platform/base was welded to the floor to accommodate the module in the proper orientation. This base was 20 cm (8") laterally and 22 cm (8.5") longitudinally with the SDM bolted to the center of this unit. The perimeter of the base was covered with a white silicone-type sealer. The SDM and base were mounted in a horizontal position that is required for proper crash sensing. The SDM was correctly oriented forward as specified by the manufacturer.

The investigating officer conducted a search of the vehicle in an attempt to download the EDR. This search involved the removal of the front right seat and the center mounted adaptive control devices. He located the SDM bolted to the center front floor (lowered floor) of the vehicle and observed the unit positioned in a vertical attitude. He successfully downloaded the EDR.

During the SCI inspection process of the vehicle, the total damage was evaluated, both exterior and interior. The SDM was observed by the SCI investigator who noted that the toe pan and forward floor pan of the lowered floor was crushed and displaced rearward. As a result of this floor deformation, the SDM's mounting platform rotated from a horizontal position to a measured angle of 60 degrees rearward **(Figure 13)**. NHTSA personnel inspected exemplar vehicles with the lowered floor that were not involved in crashes. All SDMs in these vehicles were properly oriented in a horizontal position.

Figure 13. Repositioned and rotated SDM by intrusion.

The EDR could not be downloaded during the SCI investigation. The investigating officer provided a copy of the output to NHTSA. This copy was forward to the SCI team for evaluation. Two events were recorded; a Non-Deployment file and a Deployment file. The Non-Deployment event occurred as the vehicle traversed the depressed grass median and bottomed-out as it entered the southbound travel lanes. This file recorded a vehicle speed of 100-97 km/h (62-60 mph) during the five-second window of AE and occurred 47.5 ms of AE. A time period of 0.5 seconds occurred between the two

recorded events. The Maximum Recorded Velocity Change for the Non-Deployment event was 0 km/h.

The driver's belt system was recorded as Buckled. The Maximum Recorded Velocity Change for the Deployment event was 32 km/h (19.8 mph). A Stage 2 deployment was commanded at 7.5 ms of AE for both frontal air bags. The EDR report is included as **Attachment A** at the end of this narrative report.

Manual Safety Belt Systems – 2005 Chevrolet Venture

The Chevrolet Venture was equipped with 3-point lap and shoulder belt systems for the four outboard seated positions and a center rear (third row) lap belt. There was no second row seat for this altered vehicle. The driver's belt system consisted of continuous loop webbing, a sliding latch plate and a B-pillar mounted Emergency Locking Retractor (ELR). The buckle for this system was mounted to the inboard aspect of the seat frame. The front right belt system utilized a switchable ELR/ALR retractor with the same components as the driver's belt system. These positions were equipped with adjustable D-rings.

The third row seat was equipped with continuous loop webbings, sliding latch plates, fixed D-rings and ELR/ALR retractors for the two outboard positions. The center lap belt was equipped with a locking latch plate.

The driver was restrained by the manual safety belt at the time of the crash. Rescue personnel cut the belt webbing during the extrication of the driver. The latch plate remained engaged in the seat mounted buckle at the time of the SCI investigation.

Driver Demographics – 2005 Chevrolet Venture

Age/Sex:	50-year old/Female
Height:	163 cm (64")
Weight:	94 kg (208 lb)
Seat track Position:	Unknown due to damage and vehicle modifications
Manual Safety Belt Usage:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection
Mode of Transport From Scene:	Coroner to morgue
Type of Medical Treatment:	None (autopsy)

Driver Injuries

Injury	Injury Severity (AIS/Update 98)	Injury Source
Multiple lacerations of the liver of both lobes w/near transaction at the junction between the lobes	Critical (541828.5,1)	Intruding steering wheel

Injury	Injury Severity (AIS/Update 98)	Injury Source
Complete transaction of the mid pancreas	Critical (542832.5,7)	Intruding steering wheel
Full thickness laceration of the descending thoracic aorta w/ extensive mediastinal hemorrhage	Critical (420216.5,4)	Intruding steering wheel
Multiple bilateral rib fractures; left 4-6 anteriorly, right 3-9 laterally w/ right hemothorax	Severe (450232.4,3)	Intruding steering wheel
Multiple bilateral subpleural contusion hemorrhages of the lungs	Severe (441410.4,3)	Intruding steering wheel
Acute subarachnoid hemorrhage in an irregular distribution over the cerebral convexities	Serious (140684.3,1; 140684.3,2)	Steering wheel rim (possible)
Open left femur fracture	Serious (851801.3,2)	Intruding and fractured knee bolster and sub-instrument panel
Open right femur fracture	Serious (851801.3,1)	Intruding and fractured knee bolster and sub-instrument panel
Gaping avulsive laceration below the left knee w/near traumatic amputation w/full thickness fractures of the left tibia and fibula	Serious (811002.3,2)	Intruding and fractured knee bolster and sub-instrument panel
Horizontal fracture of the lower sternum	Moderate (450804.2,4)	Intruding steering wheel rim
Right wrist fracture dislocation	Moderate (751800.2,1; 751430.2,1)	Adaptive steering system/stalk (probable)
Horizontal fracture of thoracic vertebrae T-9	Moderate (650416.2,7)	Intruding steering wheel
Multiple irregular abrasions and contusions over the bridge of the nose and the right side of the face	Minor (290202.1,4; 290402.1,4; 290202.1,1; 290402.1,1)	Driver's air bag (possible)
3 cm anterior chin abrasion	Minor (290202.1,8)	Driver's air bag
Broad contusion of the anterior surface of the lower abdomen	Minor (590402.1,8)	Intruding steering wheel rim

Injury	Injury Severity (AIS/Update 98)	Injury Source
Broad irregular abrasions of the anterior lower chest	Minor (490202.1,0)	Intruding steering wheel rim
Contusions of the dorsal right hand	Minor (790402.1,1)	Intruding instrument panel and associated components
Multiple irregular contusions of the dorsal left hand	Minor (790402.1,2)	Intruding instrument panel and associated components
Gaping laceration at the base of the right middle finger	Minor (790600.1,1)	Intruding instrument panel and associated components
Near traumatic amputation of the right middle finger	Minor (752404.1,1; 790800.1,1)	Left instrument panel
5 cm vertical laceration of the lateral left upper arm w/multiple irregular abrasions	Minor (790602.1,2; 790202.1,2)	Intruding front and left side surfaces, specific component unknown
Gaping avulsive laceration over the right leg below the knee	Minor (890800.1,1)	Intruding and fractured knee bolster and sub-instrument panel
Bilateral abrasions and contusions over the knees and upper thighs	Minor (890202.1,3; 890402.1,3)	Intruding and fractured knee bolster and sub-instrument panel

Source – Autopsy Report

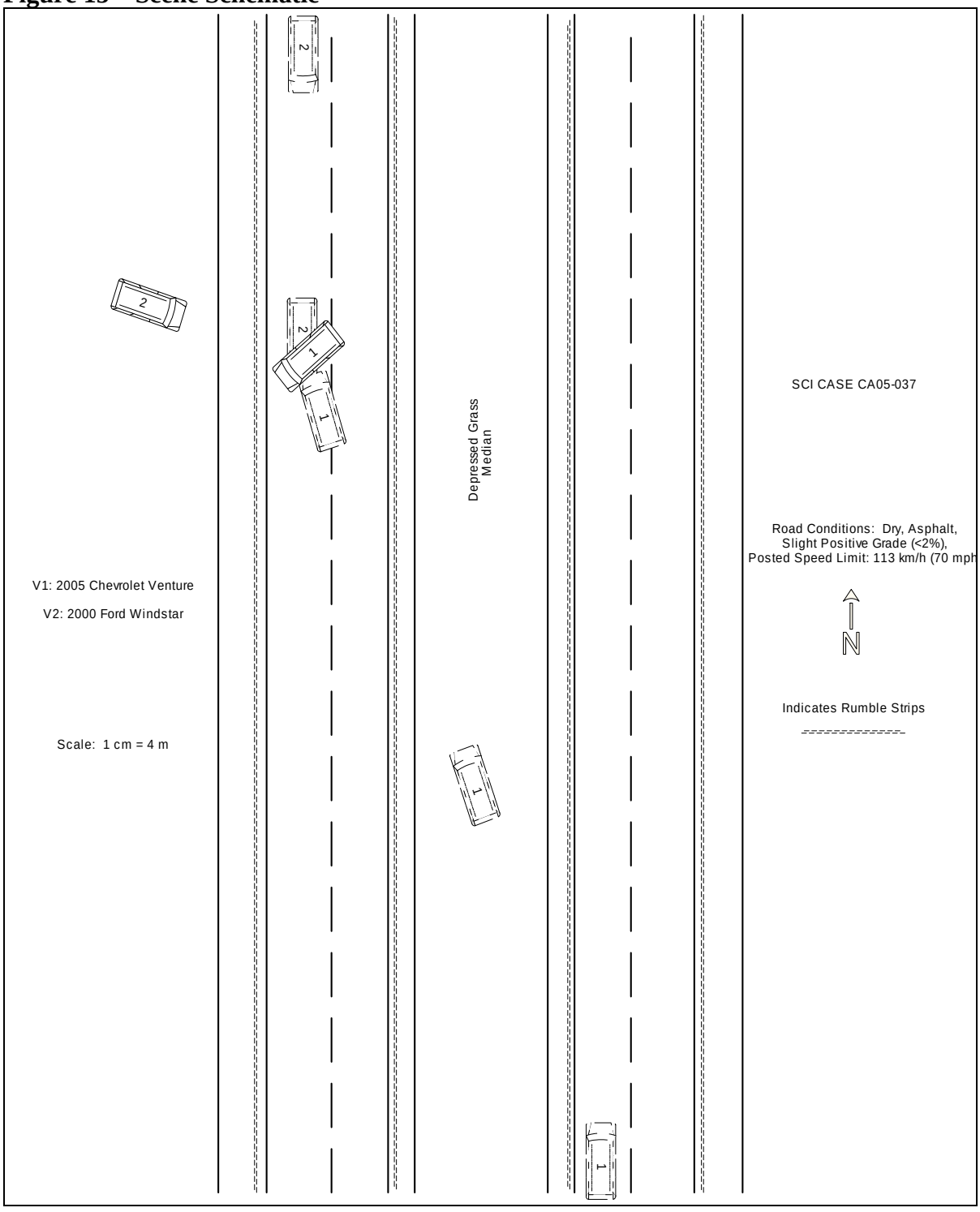
Driver Kinematics

The 50-year old female driver of the Chevrolet Venture minivan was seated in the OEM bucket seat and restrained by the manual 3-point lap and shoulder belt system. Belt usage was determined from the cut locations of the belt webbing and the engagement of the latch plate in the buckle assembly. The driver's seat was mounted to an electrically controlled base that provided swivel and height adjustments to allow for transfer to and from a wheelchair. The adjusted position of the seat was unknown due to the severe damage to the vehicle.

Figure 14. Intrusion of the driver's compartment.

At impact, the frontal air bag system deployed. The exterior crush was translated into the passenger compartment as intrusion. The left A-pillar, instrument panel, toe and floor pans and the steering assembly grossly intruded into the driver's compartment **(Figure 14)**. She initiated a forward trajectory in response to the frontal crash forces. She loaded the belt system and loaded through the deployed air bag as the steering assembly intruded rearward. Her loading of the steering assembly compressed the energy absorbing column and separated the shear brackets. The steering wheel rim was deformed approximately 13 cm (5") forward. As a result of her involvement with the intruding steering assembly, the driver sustained multiple lacerations of the liver, transaction of the pancreas, laceration of the descending aorta, multiple bilateral rib fractures, a sternum fracture, and pulmonary contusion hemorrhages.

Figure 15 – Scene Schematic



Attachment A: 2005 Chevrolet Venture EDR Report

Vetronix

CDR Crash Data Retrieval

CDR File Information

Vehicle Identification Number	1GBDV13E35D113963
Investigator	Reeder
Case Number	61-1772-05
Investigation Date	Wednesday, March 30 2005
Crash Date	Monday, March 28 2005
Filename	001-119-05.CDR
Saved on	Thursday, March 31 2005 at 09:40:56 AM
Data check information	F57A7A40
Collected with CDR version	Crash Data Retrieval Tool 2.70
Collecting program verification number	70812806
Reported with CDR version	Crash Data Retrieval Tool 2.70
Reporting program verification number	70812806
Interface used to collected data	Block number: 00 Interface version: 41 Date: 11-04-04 Checksum: 9E00
Event(s) recovered	Deployment Non-Deployment

SDM Data Limitations

SDM Recorded Crash Events:

There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded 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 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 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 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 ignition cycles.

-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 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.

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. Depending on vehicle option content, the Brake Switch Circuit Status data may not be available.

-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.

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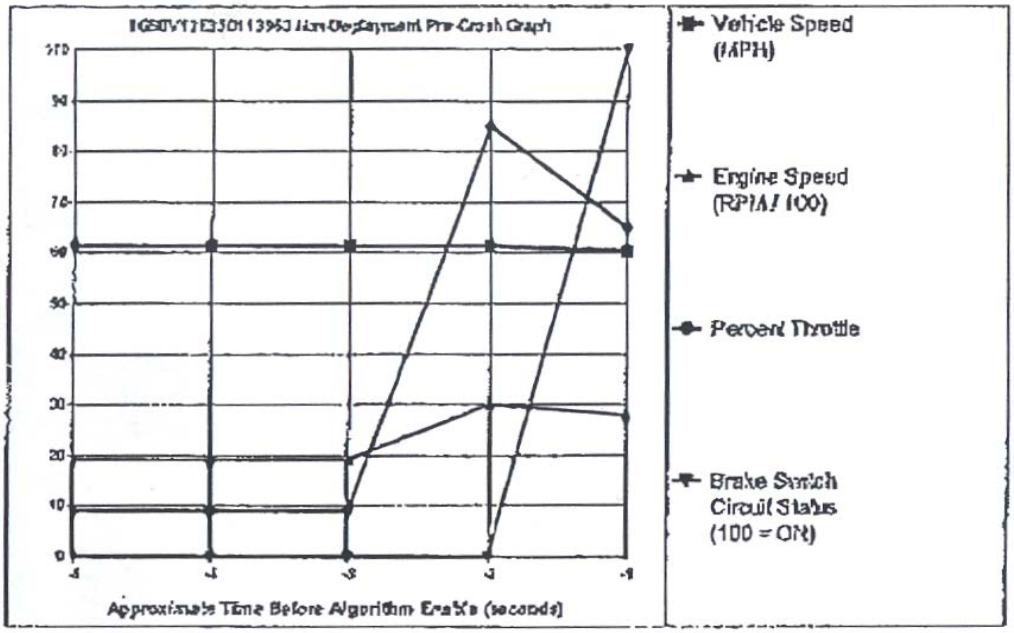
CDR CRASH DATA RETRIEVAL SYSTEM

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	397
Ignition Cycles At Investigation	399
Maximum SDM Algorithm Forward Velocity Change (MPH)	0.00
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	47.5
A Deployment was Commanded Prior to this Event	No



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	62	1856	9	OFF
-4	62	1856	9	OFF
-3	62	1856	9	OFF
-2	62	3006	65	OFF
-1	69	2752	65	ON

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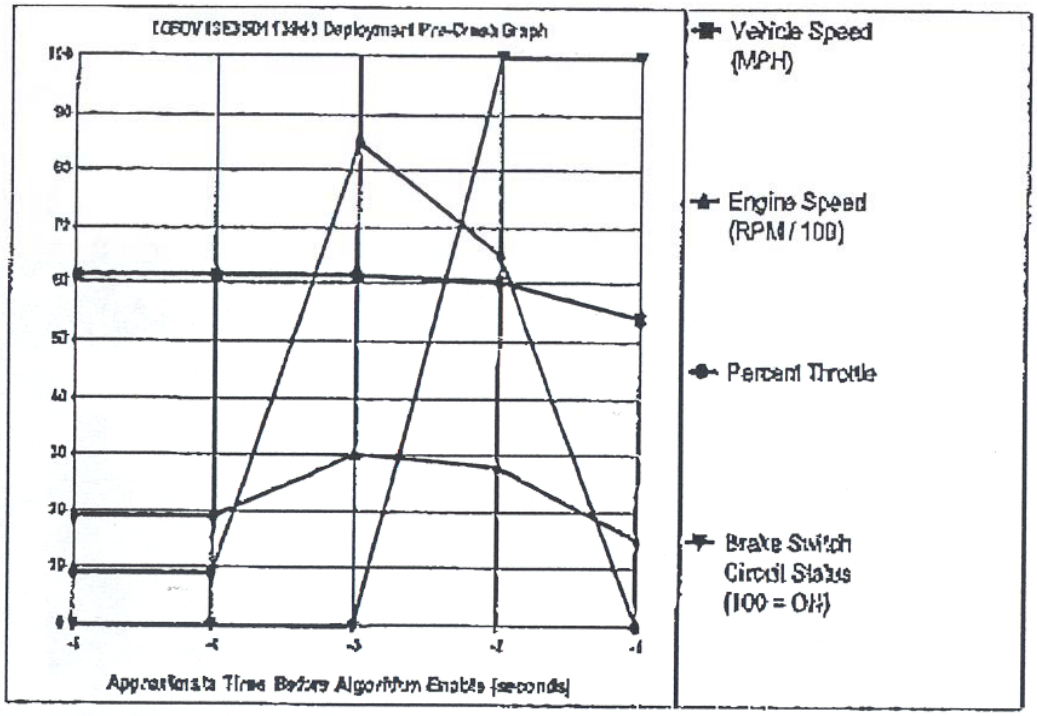
CDR CRASH DATA RETRIEVAL

System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	337
Ignition Cycles At Investigation	339
Maximum SDM Algorithm Forward Velocity Change (MPH)	-19.8
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	32.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	7.5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	7.5
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	7.5
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	7.5
Time Between Non-Deployment And Deployment Events (sec)	.5
Event Recording Complete	Yes



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	62	1856	9	OFF
-4	62	1856	9	OFF
-3	62	3008	85	OFF
-2	60	2752	65	ON
-1	54	1536	0	ON

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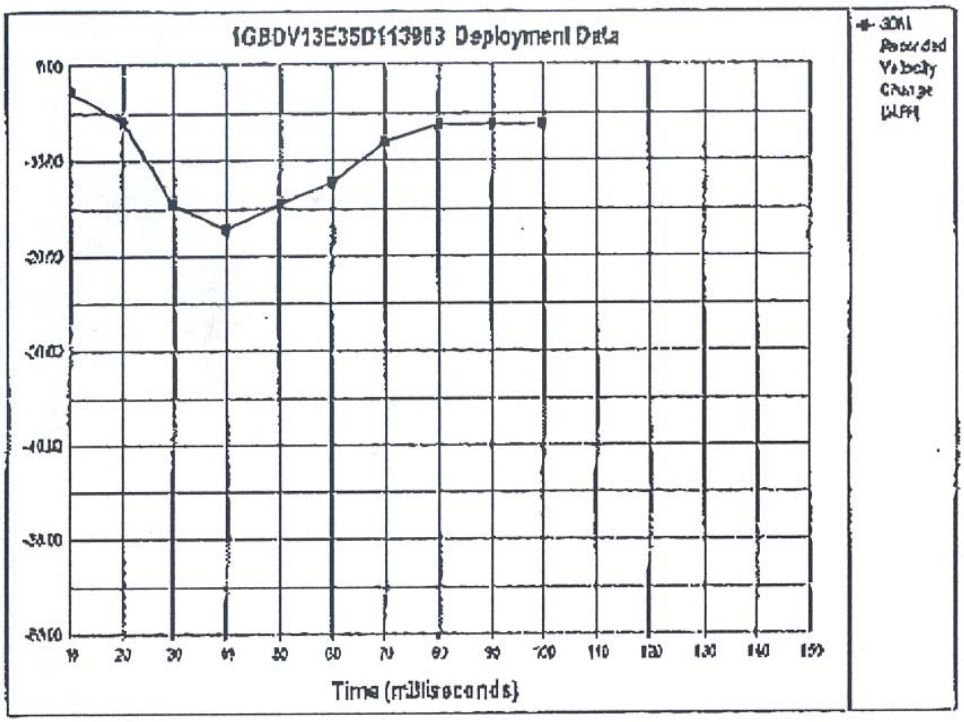
CDR CRASH DATA RETRIEVAL



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
SDM Recorded Velocity Change	-2.63	-5.29	-14.63	-17.88	-14.66	-12.28	-9.80	-7.11	-6.34	-6.34	NA	NA	NA	NA	NA

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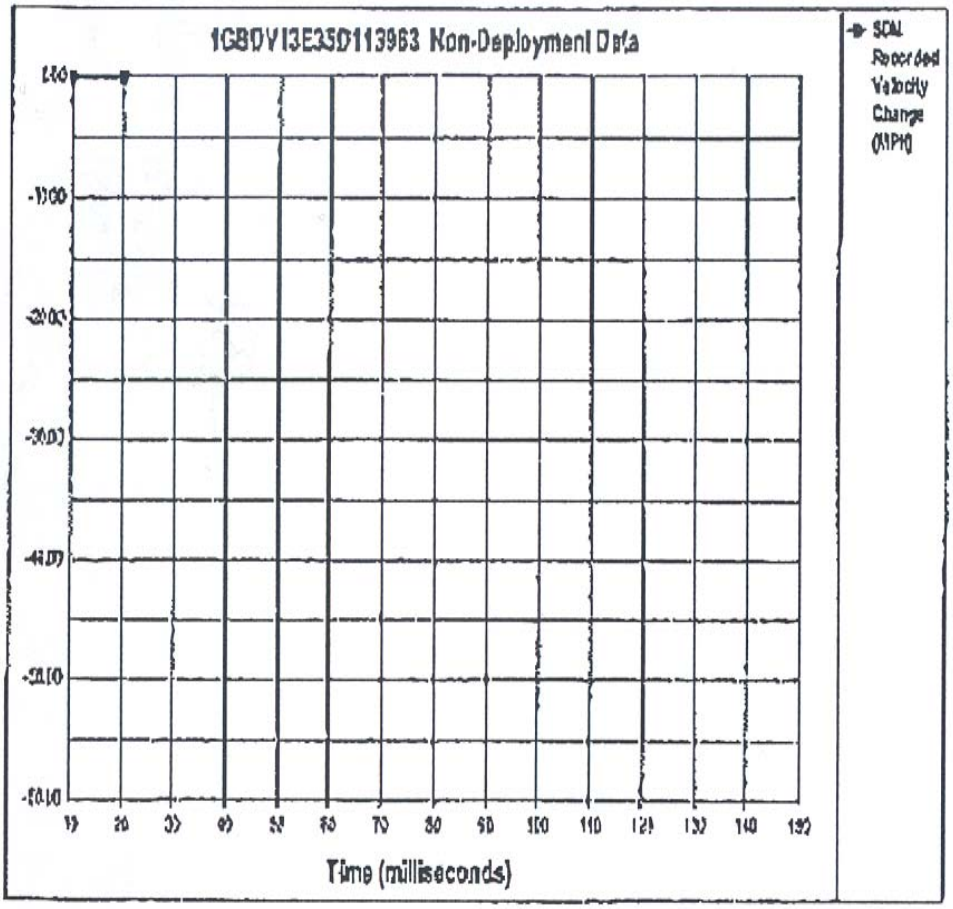
CDR CRASH DATA RETRIEVAL



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

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CDR CRASH DATA RETRIEVAL

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  AD 2C 2A 35 00 00
$02  BC 75 00 00 00 00
$03  41 53 34 31 35 34
$04  4B 47 54 31 44 32
$05  02 41 01 01 00 00
$06  10 35 49 31 00 00
$10  FB C6 80 00 00 00
$11  A3 00 93 00 00 61
$12  00 00 00 00 00 00
$13  03 00 00 00 00 00
$14  FF 14 EB 80 55 00
$1B  81 80 82 78 7E 80
$1C  FA FA FA FA FA FA
$1D  FA FA FA FA FA FA
$1E  FA FA 00 00 00 00
$1F  FF D2 00 00 00 00
$20  80 00 00 DC F0 00
$21  FF FF FF FF FF FF
$22  FF FF FF FF 00 00
$23  00 00 FF FF FF FF
$24  FF FF FF FF FF FF
$25  FF FF FF 02 00 00
$26  61 63 63 63 63 80
$27  A6 DA 1B 1B 1B 00
$28  7B 2F 1D 1D 1D 00
$29  FF CF E0 00 00 00
$2A  00 00 00 32 00 00
$2B  00 00 00 00 00 00
$2C  00 00 FF 00 00 00
$2D  00 00 00 00 00 00
$2E  00 00 00 00 00 00
$30  00 00 00 0C F0 00
$31  FF FF FF FF FF FF
$32  FF FF FF FF 00 00
$33  06 06 07 07 03 03
$34  04 04 06 0D 21 27
$35  21 1C 12 0E 0B 0E
$36  FF FF FF FF FF 0A
$37  57 61 63 63 63 C0
$38  00 A6 DA 1B 1B 00
$39  1B 2B 2F 1D 1D 00
$3A  FF CF E0 2D 00 00
$3B  11 11 11 11 00 00
$3C  15 05 A6 00 00 AA
$3D  00 00 00 00 00 00
$3E  00 00 00 00 00 00
$40  FF FF FF FF FF 00
$41  87 FF FF FF FF FF
$42  FF FF FF FF 00 00
$43  FF FF FF 00 00 00
$44  FF 00 00 00 00 00
$50  00 00 00 00 00 00
$51  A3 AA 00 00 00 00
$60  03 03 03 03 20 08
$61  0D 00 00 00 00 00
```