CRASH DATA RESEARCH CENTER

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Buffalo, NY 14225

CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION

CASE NO: CA04-002

VEHICLE: 2003 FORD CROWN VICTORIA POLICE INTERCEPTOR

LOCATION: NEW YORK

CRASH DATE: JANUARY 2004

Contract No. DTNH22-01-C-17002

Prepared for:

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

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

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

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CASE NO.: CA04-002
LOCATION: AMHERST, NY
VEHICLE: 2003 FORD CROWN VICTORIA POLICE INTERCEPTOR
CRASH DATE: JANUARY 17, 2004

BACKGROUND

This on-site investigative effort focused on the performance of the deployed Side Impact Inflatable Occupant Protection System in a 2003 Ford Crown Victoria Police Interceptor (CVPI) and the resulting injury mechanisms for the 29-year-old male restrained police officer. The CVPI **(Figure 1)** was involved in an intersection crash with a 2002 Chevrolet Trailblazer. The driver of the 2002 Chevrolet Trailblazer was driving under the influence of alcohol. He was operating the vehicle in an eastbound direction on a four-lane roadway and initiated a left turn as the CVPI was traveling through the intersection. The front of the Trailblazer struck the left side aspect of the CVPI. The impact was sufficient to deploy the driver's seat back-mounted side impact air bag, driver's frontal air bag, and the driver's safety belt pretensioner in the CVPI. The frontal air bag system did not deploy in the Trailblazer. The driver of the CVPI initiated a forward and lateral trajectory to the left and loaded the safety belt, deployed side impact air bag, and the deployed driver's frontal air bag. The CVPI was redirected in a counterclockwise (CCW) rotation, and struck a curb and a snow bank with the left side wheels. The curb impact tripped the CVPI into a four quarter-turn rollover onto the roadside. The CVPI came to rest upright in a roadside parking lot. The driver of the CVPI sustained police-reported herniated cervical discs and a fractured elbow. He was transported by ambulance to a regional trauma center for treatment and released.

Figure 1. On-scene view of the damaged CVPI

This crash was identified by the involved police agency who forwarded the crash information to the Calspan Special Crash Investigations Team. The notification was forwarded to the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) due to the side impact air bag deployment in the CVPI. An on-site investigation was assigned on January 22, 2004. A copy of the Police Accident Report (PAR) was obtained from the investigating agency.

SUMMARY

Vehicle Data – 2003 Ford Crown Victoria Police Interceptor (CVPI)

The 2003 CVPI was identified by the Vehicle Identification Number (VIN): 2FAHP71W03X (production sequence omitted). The vehicle's odometer reading was 76,102 km (47,289 miles) at the time of the vehicle inspection. The CVPI was configured with the Police Interceptor package which included a 4.6L overhead cam SEFI V8 engine, an electronically controlled automatic transmission with overdrive and transmission oil cooler, heavy duty frame, steering gear, body mounts and suspension, power 4-wheel disc brakes with an anti-lock braking system (ABS),

power, speed-sensitive steering, variable assist and power steering oil cooler and a Personal Safety System™ Advanced Occupant Safety System (AOPS), which included dual stage front air bags, safety belt pretensioners, a driver's seat track position sensor, and a front right seat position weight sensor.

The CVPI was equipped with Goodyear Eagle RSA P225/60R16 tires on each front wheel and Goodyear Eagle Ultra Grip P225/60R16 snow tires on each rear wheel. The manufacturer's recommended tire pressure for each tire was 240 kPa (35 PSI). The specific tire data is as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0.0 kPa	5.6 mm (7/32")	No	Debeaded
LR	0.0 kPa	5.6 mm (7/32")	No	Debeaded
RF	220.6 kPa (32.0 PSI)	5.6 mm (7/32")	No	None
RR	220.6 kPa (32.0 PSI)	6.4 mm (8/32")	No	None

The CVPI was a departmental vehicle and was used continuously for each shift within a 24-hour period (24/7).

The front seating positions in the Ford Crown Victoria were configured with power-adjusted bucket seats with adjustable head restraints. At the time of the vehicle inspection, the driver's seat was positioned 17.8 cm (7.0") rear of full forward and 5.7 cm (2.3") forward of full rear. The height of the leading edge of the seat was raised 7.6 cm (3.0") above the full-down position and the seat cushion angle measured 25 degrees from horizontal. The seat back was slightly reclined and measured 25 degrees from vertical. The driver's head restraint was separated from the seat back. The rear seating positions were configured with a single bench seat. There were no head restraints on the rear seat back. Lower Anchors and Tethers for Children (LATCH) anchors were present for each outboard rear seat and tether anchors for child safety seats were present on the rear deck behind each seating position.

The interior of the CVPI was configured with police radios, radar equipment, and a laptop computer module between the front bucket seats. A center console was mounted to the floor between the front seats and housed two-way radio equipment, siren controls, and emergency light controls. A full-width safety-cage was installed between the B-pillars, separating the front and rear seating areas. The laptop computer, radar equipment, and safety cage had been removed from the CVPI at the time of the vehicle inspection.

The contents of the CVPI's trunk included video camera equipment mounted on the forward left aspect of the trunk's upper deck, a large plastic storage bin that contained a cardboard box of traffic flares, five traffic cones, and a first aid kit.

Vehicle Data – 2002 Chevrolet Trailblazer

The 2002 Chevrolet Trailblazer was identified by the VIN: 1GNDT13S922 (production sequence omitted). The vehicle was a four-door 4 x 4 sport-utility-vehicle that was equipped with a 4.2 liter, six cylinder engine, a four-speed automatic transmission, Autotrac system (stability control system), power four-wheel disc brakes with ABS, power steering, a tilt steering wheel, and

OnStar. The Trailblazer was equipped with BF Goodrich Rugged Trail T/A P245/65R17 tries on alloy wheels. The manufacturer's recommended pressure for each tire was 220 kpa (32 psi). The specific tire information is as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	196.1 kPa (28.0 PSI)	5.6 mm (7/32")	No	None
LR	165.5 kPa (24.0 PSI)	6.4 mm (8/32")	No	None
RF	189.6 kPa (27.5 PSI)	5.6 mm (7/32")	No	None
RR	172.4 kPa (25.0 PSI)	5.6 mm (7/32")	No	None

The front seating positions in the 2002 GMC Envoy were configured with bucket seats with adjustable head restraints. Both head restraints were in the full down position at the time of the vehicle inspection. Both front bucket seats were equipped with power seat adjustments. The rear seating positions were configured with a 60/40-split bench with folding backs. The bench seat backs were configured with head restraints on the outboard positions that folded rearward when the seat backs were folded forward.

Crash Site

This two-vehicle crash occurred during the nighttime hours of January 2004 in the state of New York. At the time of the crash, it was snowing heavily and the asphalt roadway surface was snow-covered. The crash occurred at a four-leg intersection of a north/south local roadway and an east/west arterial roadway. The east/west roadway was configured with two travel lanes in each direction that were separated by a paved center left-turn lane. Concrete curbs and concrete sidewalks bordered the roadway, and the roadside environment consisted of commercial properties. The north leg of the intersection was configured with a two-lane, undivided roadway that was bordered by concrete curbs and residential properties. The south leg was configured with an undivided two-lane private roadway bordered by concrete curbs that lead to a school. The crash occurred on the northwest corner of the intersection. A parking lot and commercial building were located on the northwest corner. At the time of the crash, snow banks that measured approximately 1 m (3') in height were present around the perimeter of the parking lot. Traffic flow through the intersection was controlled by three-phase traffic signals. The posted speed limit for the east/west roadway was 72 km/h (45 mph). The intersection was located within a posted school zone, which had a stated speed limit of 56 km/h (35 mph) between the hours of 7 am and 6 pm on school days. The posted speed limit for the north/south roadway was 48 km/h (30 mph). The scene schematic is included as **Figure 11** of this narrative report.

Crash Sequence

Pre-Crash

The 29-year-old male driver of the CVPI was operating the vehicle in a westbound direction on the four-lane roadway **(Figure 2)** on approach to the four-leg intersection. His pre-impact travel speed was unknown, but most likely below the posted speed limit due to snow conditions. The 47-year-old driver of the Chevrolet Trailblazer was operating the vehicle in an eastbound direction on the four-lane roadway **(Figure 3)** on approach to the intersection. The traffic signal was in the green phase for east/west traffic and the driver of the CVPI proceeded through the intersection. Although the CVPI was traveling through the intersection, the driver of the Trailblazer entered the intersection and initiated a left turn toward the CVPI. The pre-crash data from the Trailblazer's Event Data Recorder (EDR) identified a vehicle speed of 35 km/h (22 mph) five seconds prior to impact. The EDR data also identified a brake application three seconds prior to impact and brake release one second prior to impact. The Trailblazer's EDR-reported speed one second prior to impact was 34 km/h (21 mph) with the throttle applied at 14 percent.

Figure 2. Westbound approach for the 2003 Ford CVPI

Figure 3. Eastbound approach for the 2002 Chevrolet Trailblazer

Crash

The front aspect of the Trailblazer impacted the left side passenger area of the CVPI. The impact resulted in moderate damage to both vehicles and was sufficient to deploy the first and second stages of the driver's frontal air bag, driver's safety belt pretensioner, and the driver's seat back-mounted side impact air bag. The damage algorithm of the WinSMASH program computed a total delta-V of 16.0 km/h (9.9 mph) for the CVPI based on the left side crush profile, with a longitudinal component of -10.3 km/h (-6.4 mph). The maximum EDR-reported longitudinal cumulative delta-V for the CVPI was -9.77 km/h (-6.07 mph), which occurred 68 milliseconds into the event. The damage algorithm of the WinSMASH program computed a total delta-V of 15.0 km/h (9.3 mph) for the Trailblazer based on the frontal crush profile. The EDR-reported Maximum SDM Recorded Velocity Change for the Trailblazer was 16.0 km/h (9.9 mph). The left rear tire/wheel of the CVPI snagged the front right corner of the Trailblazer, which resulted in a slight counterclockwise (CCW) rotation of the Trailblazer. The impact deflected the CVPI into a counterclockwise (CCW) rotation approximately 180 degrees before the left tires/wheels of the CVPI struck the curb face, which tripped a four-quarter turn rollover about its longitudinal axis, with the left side leading. The CVPI rolled laterally through the snow bank on the outboard

aspect of the parking lot and came to rest upright in the center aspect of the lot facing north. The Trailblazer came to rest facing north, with the front wheels positioned on the sidewalk.

Post-Crash

It was not known how the driver of the Trailblazer exited the vehicle. Rescue personnel removed the driver of the CVPI from the vehicle. Rescue personnel to facilitate the extrication of the driver removed the roof of the CVPI. He was transported by ambulance to a regional trauma center for treatment and then released.

Vehicle Damage

Exterior Damage – 2003 Ford CVPI

The 2003 Ford CVPI sustained moderate left side damage **(Figure 4)** as a result of the impact with the Chevrolet Trailblazer. At the time of the vehicle inspection, both left doors, left B-pillar, and roof had been removed by rescue personnel, but were available for inspection. The direct contact damage began at the leading edge of the left front door and extended rearward 246.4 cm (97.0”). Lateral crush and deformation were present on both left side doors. Longitudinal abrasions were present on both left side doors from direct engagement with the front of the Trailblazer, which extended vertically to the beltline. The left sill sustained lateral crush from the impact, and the maximum crush measured 15.2 cm (6.0”) at the rear aspect of the left sill. The forward aspect of the left rear quarter panel sustained pocketing as a result of the Trailblazer rotating against the rear aspect of the sill. The snagging of the Trailblazer against the left rear tire/wheel of the CVPI displaced the left rear wheel rearward which elongated the left wheelbase by 10.9 cm (4.3”). The combined direct and induced damage measured 246.4 cm (97.0”) from the leading edge of the left front door to the end of the deflection point on the left rear quarter panel. The left aspect of the rear bumper fascia was displaced. Due to the removal of the left side doors and masking left side damage from the rollover event, a crush profile was documented along the left sill. Six crush measurements were documented along the entire length of the left sill, which measured 188.0 cm (74.0”), and were as follows: C1 = 15.2 cm (6.0”), C2 = 12.7 cm (5.0”), C3 = 12.1 cm (4.8”), C4 = 8.9 cm (3.5”), C5 = 6.4 cm (2.5”), C6 = 2.5 cm (1.0”). The Collision Deformation Classification for the initial impact with the Trailblazer was 10-LPEW-2.

Figure 4. Left side view of damaged 2003 Ford CVPI

The 2003 Ford CVPI also sustained moderate damage as a result of the subsequent rollover event. Due to the snow accumulation, abrasions from direct ground contact were limited. Minor lateral abrasions were present on the hood. Angled abrasions were present on the rear aspect of the right rear door and minor deformation was noted to both right side door panels as a result of the rollover. The outboard aspects of the roof sustained minor deformation, and the right side plastic dome of the roof-mounted light bar was fractured. There was no residual roof crush. The CDC for the rollover event was 00-TDDO-1.

Interior Damage – 2003 Ford CVPI

The 2003 Ford CVPI sustained minor interior damage as a result of passenger compartment intrusion. The driver's head restraint was separated from the top of the seat back, and sustained a tear on the rear outboard aspect, possibly as a result of rescue operations. As shown in **Figure 5**, the center console, which housed the radio and emergency lighting controls, was displaced laterally to the left. The outboard aspect of the left rear seat and seat back were buckled inward due to the lateral intrusion. The specific intrusions were documented as follows:

Figure 5. Interior view of the front seating positions in the 2003 Ford CVPI

Position	Intruded Component	Magnitude of Intrusion	Direction
LF	Left sill	21.6 cm (8.5")	Lateral
LF	Left B-pillar	17.8 cm (7.0")	Lateral
LR	Left sill	16.5 cm (6.5")	Lateral
LR	Left C-pillar	26.7 cm (10.5")	Lateral
LR	Left outboard seat back	27.9 cm (11.0")	Lateral
LF	Door Panel	15.0 – 30.0 cm (38.1 - 76.2")	Lateral
LR	Door Panel	15.0 – 30.0 cm (38.1 - 76.2")	Lateral

The contents of the CVPI's trunk were displaced as a result of the crash and subsequent rollover. The video camera equipment was completely displaced from the mounting hardware. There were no penetrations of the trunk wall or fuel tank.

Exterior Damage – 2002 Chevrolet Trailblazer

The 2002 Chevrolet Trailblazer sustained moderate frontal damage **(Figure 6)** as a result of the frontal impact with the Ford CVPI. The direct contact damage began at the left front bumper corner and extended 154.9 cm (61.0") across the entire frontal plane. Red paint transfers from the CVPI began at the left front corner of the hood, extended laterally across the leading edge of the hood 111.8 cm (44.0"), and terminated 40.6 cm (16.0") right of the centerline. Red paint transfers were also present across the left front headlamp. The front bumper fascia and grille were separated from the Trailblazer. The bumper beam was deformed and crushed rearward. The combined direct and induced damage involved the entire frontal width of the vehicle. The hood was buckled rearward and left front fender was buckled outward. Six crush measurements were documented across the front

Figure 6. Frontal damage to the 2002 Chevrolet Trailblazer

bumper beam of the Trailblazer and were as follows: C1 = 24.8 cm (9.8”), C2 = 5.7 cm (2.3”), C3 = 12.7 cm (5.0”), C4 = 14.0 cm (5.5”), C5 = 3.8 cm (1.5”), C6 = 7.6 cm (3.0”). The CDC for the frontal impact with the Ford CVPI was 01-FDEW-1.

Manual Restraint System – 2003 Ford CVPI

The 2003 Ford CVPI was equipped with continuous loop, manual 3-point lap and shoulder belts for each seating position. The driver’s safety belt was configured with a belt-sensitive, Emergency Locking Retractor (ELR) and the remaining safety belts were configured with belt-sensitive, switchable ELR/Automatic Locking Retractors (ALR). The rear outboard restraints retracted into the inboard aspects of the C-pillars, and the center safety belt retracted into the retractor housing located on the center aspect of the rear deck above the seat back. The driver’s adjustable D-ring was in the full-down position at the time of the vehicle inspection. Rescue personnel had cut the driver’s safety belt in two locations. The first cut was located 31.8 cm (12.5”) from the lower anchor and the second cut was located 197.5 cm (77.8”) from the anchor. As shown in **Figure 7**, The safety belt webbing was gathered in the forward aspect of the D-ring 118.1 cm (46.5”) above the anchor.

Figure 7. View of separated left B-pillar and driver's safety belt webbing

The retractor **(Figure 8)** was located on the lower B-pillar, and was restricted at the time of the vehicle inspection with a length of webbing that measured 34.9 cm (13.8”). Two linear diagonal scuffmarks were present on the inside aspect (against the occupant) of the shoulder belt and were located 19.1 cm (7.5”) below to the D-ring (relative to the anchor). The scuffmarks measured the entire width of the webbing and were heavier on the outboard aspect.

Figure 8. View of driver's safety belt retractor and pretensioner

Advance Occupant Protection System (AOPS) –2003 Ford CVPI

The 2003 Ford CVPI was equipped with an AOPS that included dual-stage frontal air bags for the driver and front right passenger positions, front seat retractor pretensioners, a seat track position sensor for the driver’s seat track, a front right occupant presence detection system, and an Event Data Recorder (EDR). The air bag system was equipped with a sensor on the driver’s seat track that was designed to adjust the deployment of the driver’s air bag based on crash severity, the driver’s seat track position, and safety belt usage. The EDR output is included as **Appendix A** of this report.

The dual-stage driver's air bag deployed as a result of the longitudinal deceleration during the impact with the Chevrolet Trailblazer. The driver's air bag **(Figure 9)** was housed in the center of the steering wheel hub with a single cover flap design. The cover flap was hinged at the top aspect and measured 14.6 cm (5.8") in width and 11.4 cm (4.5") in height. The driver's air bag measured 61.0 cm (24.0") in diameter. The air bag was vented by two circular ports located on the rear aspect of the air bag at the 11 and 1 o'clock positions, located 5.1 cm (2.0") inboard of the circumferential seam. The vent ports measured 2.5 cm (1.0") in diameter. The air bag was tethered by two internal straps that measured 7.6 cm (3.0") in width and were located at the 12 and 6 o'clock positions of the center of the air bag. There was no evidence present on the driver's air bag from occupant contact.

Figure 9. View of deployed driver's air bag

The front safety belts were equipped with retractor pretensioners that were designed to fire in conjunction with the frontal air bag system. The driver's pretensioner actuated in this crash.

Side Impact Occupant Protection System- 2003 Ford CVPI

The 2003 Ford CVPI was equipped with seat-back mounted side impact air bags for the driver and front right passenger positions. The side impact air bags were designed to provide head and torso protection.

Figure 10. View of deployed driver's side impact air bag

The driver's side impact air bag deployed as a result of the left side impact with the Chevrolet Trailblazer. The side air bag **(Figure 10)** deployed through a tear seam along the outboard edge of the seat back that measured 38.1 cm (15.0") in length. The air bag was rectangular in shape and measured 63.5 cm (25.0") in height and 34.3 cm (13.5") in width. The forward excursion of the side impact air bag measured 25.4 cm (10.0") from the seat back. The air bag was tethered by two internal straps that measured 2.5 cm (1.0") laterally, measured 10.2 cm (4.0") in width, and were located 14.0 cm (5.5") and 31.1 cm (12.5") from the top of the air bag, respectively.

There was no occupant contact evidence on the driver's side impact air bag. The top inboard corner sustained faint scuffmarks and minor tears from rescue operations and post-crash debris.

Event Data Recorder (EDR) – 2003 Ford CVPI

The 2003 Ford CVPI was equipped with an EDR that was located in the CVPI's Restraints Control Module (RCM). The RCM was positioned on the floor of the vehicle under the center console. The CVPI had power at the time of the inspection; therefore, the EDR was downloaded

through the Diagnostic Link Connector (DLC). The EDR summary showed a Deployment Event was recorded.

The Deployment Event indicated that the frontal air bag system was commanded to deploy as a result of the longitudinal deceleration the CVPI experienced during the left side impact with the Trailblazer. The Maximum-recorded longitudinal delta-V was -9.77 km/h (-6.07 mph), and was recorded 68.8 milliseconds into the event. According to the System Status At Deployment, the impact was sufficient to command a dual-stage deployment of the frontal air bag system and the firing of both safety belt pretensioners, whether or not the occupants were belted. The driver's seat belt buckle was reported as "Buckled", and the system indicated the driver's seat track was not in a forward track position. The Occupant Classification Status Value of "Off" signaled the lack of occupancy in the front right seat, which resulted in the suppression of the front right passenger's air bag and front right safety belt pretensioner. The driver's pretensioner and first stage deployment of the driver's air bag occurred 60 milliseconds into the event, and the second stage of the driver's air bag deployed 69.6 milliseconds into the event.

Event Data Recorder – 2002 Chevrolet Trailblazer

The 2002 Chevrolet Trailblazer was equipped with an EDR that was located in the vehicle's Sensing and Diagnostic Module (SDM). The SDM was positioned on the floor of the vehicle under the center console. Since the Trailblazer had power at the time of the inspection, the EDR was downloaded through the Diagnostic Link Connector (DLC). The EDR summary showed a Non-Deployment Event that was recorded.

The SDM Recorded Maximum Velocity Change was -18.30 km/h (-11.37 mph). The data also indicated that the SIR Warning Lap Status was "Off", the Driver's Belt Switch Circuit Status was "Unbuckled", the Time From Algorithm Enable to the Maximum SDM Recorded Velocity Change was 130 milliseconds, that the brake was not applied, and the throttle was engaged. Five seconds of pre-crash data were reported in one-second intervals, which indicated that the driver of the Trailblazer had applied the brakes four seconds prior to the impact as the vehicle approached the intersection, released the brakes two seconds prior to impact, and engaged the throttle as he initiated the left turn. The Trailblazer was traveling 34 km/h (21 mph) one second before impact. The downloaded EDR data is included as **Attachment B** at the end of this report.

Occupant Demographics – 2003 Ford CVPI

Driver

Age/Sex:	29-year-old male
Height:	Not available
Weight:	Not available
Seat Track Position:	17.8 cm (7.0") rear of full forward and 5.7 cm (2.3") forward of full rear
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection, EDR summary
Eyewear:	Not available
Type of Medical Treatment:	Transported by ambulance to a regional trauma center for treatment and released

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Left elbow contusion	Minor (790402.1,2)	Left door panel
Left hip contusion	Minor (890402.1,2)	Left door panel
Left digit lacerations	Minor (790602.1,2)	Unknown interior component
Right wrist abrasion	Minor (790202.1,1)	Driver air bag
Left ring finger contusion	Minor (790402.1,2)	Unknown interior component
Lumbar spine strain	Minor (640678.1,8)	Impact forces
Neck contusion	Minor (390402.1,9)	Unknown interior component

Injury source: Hospital Records

Driver Kinematics

The 29-year-old male driver of the 2003 Ford CVPI was seated in an upright posture with the seat track adjusted 17.8 cm (7.0”) rear of full forward and 5.7 cm (2.3”) forward of full-rear. At impact, the driver’s side impact air bag deployed, the driver’s frontal air bag deployed, and the driver’s safety belt pretensioner actuated. The driver initiated a slightly forward and lateral trajectory to the left. Based on his trajectory, he loaded the forward aspect of the deployed side impact air bag with his head and torso, which mitigated contact with the left side glazing and interior door panel. His face also contacted the deployed driver’s frontal air bag, which prevented contact with the steering wheel rim. He was redirected laterally to the left as the vehicle rotated CCW. The driver was further redirected in the vehicle as the CVPI initiated the trip over. Although the safety belt prevented significant movement in the vehicle, he sustained a lumbar strain as a result of motion due to the impact, rotation and rollover. He also sustained an abrasion on his right wrist from the frontal driver air bag and superficial injuries to his left elbow, left hand, left hip and neck as a result of contact with an interior surface during the crash sequence. The driver was removed from the vehicle by rescue personnel and transported to a regional trauma center where he was treated for his injuries and released.

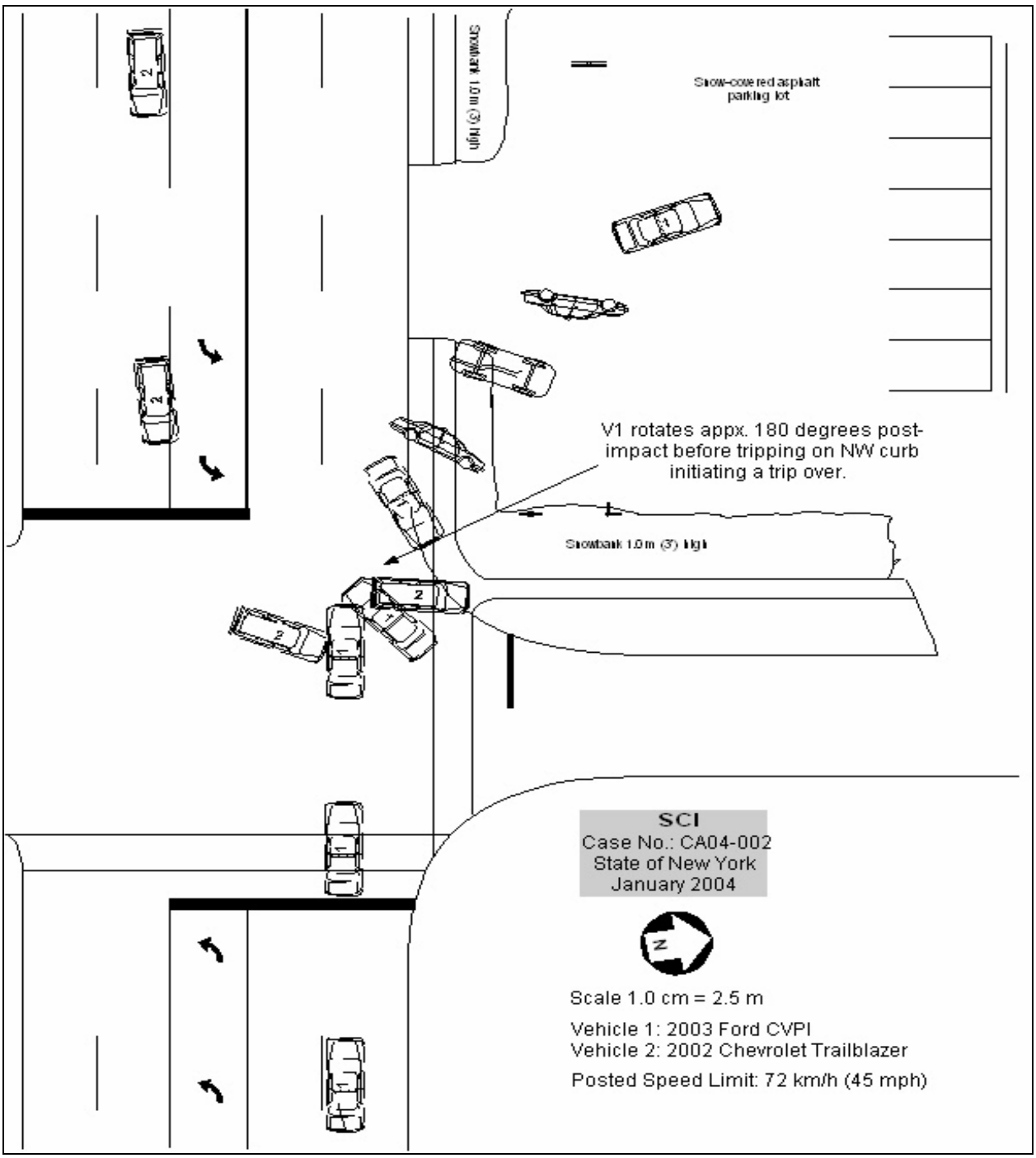


Figure 11. Scene schematic

Attachment A
EDR Report – 2003 Ford Crown Victoria Police Interceptor

CDR File Information

Vehicle Identification Number	2FAHP71W03Xxxxxx
Investigator	
Case Number	CA04-002
Investigation Date	1/23/04
Crash Date	1/17/04
Filename	CA04-002 CVPI.CDR
Saved on	1/23/2004 2:37:46 PM
Data check information	7320D40F
Collected with CDR version	Crash Data Retrieval Tool 2.00
Collecting program verification number	A31D1C76
Reported with CDR version	Crash Data Retrieval Tool 2.24
Reporting program verification number	70CD83DD
Interface used to collected data	Block number: 00 Interface version: 35 Date: 01-02-03 Checksum: 6200
Event(s) recovered	Deployment

Module Information

The retrieval of this data has been authorized by the vehicle's owner, or other legal authority such as a subpoena or search warrant, as indicated by the CDR tool user on January 23, 2004, at 2:37 PM.

Important Limitations on Vetronix Crash Data Retrieval (CDR) Tool Capabilities.

Disclaimer: This Restraint Control Module (RCM) records longitudinal deceleration data for the purpose of understanding the input data the Restraint Control Module used to determine whether or not to deploy restraint devices. This module does not record vehicle speed, throttle position, brake on-off, and other data, which may be recorded in some 1999 model year and later General Motors modules. The deceleration data recorded by Ford's module during a crash can subsequently be mathematically integrated into a longitudinal Delta-V. Delta-V is the change in velocity during the recording time and is NOT the speed the vehicle was traveling before the accident, and is also not the Barrier Equivalent Velocity. The Vetronix CDR Tool will read and interpret both acceleration in G's and Delta-V in mph. RCM's in Ford vehicles that can be read by the Vetronix CDR tool are listed in the Vetronix Help Files.

Important

If there is any question that the restraint system did not perform as it was designed to perform, please read the system only through the diagnostic link connector. The Vetronix CDR kit provides an RCM interface cable to plug directly into the restraint control module. The Vetronix CDR RCM Interface Cable connects only power, ground, and memory read pins to the relevant vehicle restraint control module. The other RCM pins normally connect to inputs, such as sensors, and outputs, such as airbags, are not connected when you use the RCM Interface Cable to plug directly into the module. Since the vehicle restraint control module is constantly monitoring airbag system readiness, it will detect that the sensors and airbags are not connected. The restraint control module may record a new diagnostic trouble code into memory for each device that is not connected. These new diagnostic trouble codes may record over previously written diagnostic trouble codes present prior to the accident and spoil evidence necessary to determine if the restraint system performed in the accident as it was designed to perform. Not only could this prevent Ford from being able to determine if the system performed as it was designed to perform, but, regardless of innocent inadvertence, you could raise issues of evidence spoliation in any litigation that may arise out of the accident. If you cannot read the module via the diagnostic link connector, and if you suspect improper system performance, contact Ford Motor Company and request their assistance to read the module with a proper vehicle simulator attached. If you choose to read via the module connector, Ford recommends that you do so in the vehicle and that you leave the second large connector plugged into the vehicle wiring harness to minimize the number of new diagnostic trouble codes created.

While data stored in RCM's is accurate, accident reconstructionists must be aware of the limitations of the data recorded in Ford's control modules and should compare the recorded data with the physical evidence at the accident scene using professional accident reconstruction techniques (i.e. vehicle crush characteristics, skid marks, etc) before making any assumptions about the import and validity of the data recorded in the module with respect to the crash event being analyzed. The following describes specific limitations that must be considered when analyzing recorded data. Investigators should obtain permission of the vehicle owner prior to reading any data.

1. There may be no deceleration data recorded in the module.
Loss of power (cut wires, damaged battery, crushed fuse box) to the module during or immediately after the crash may prevent the crash data from being recorded. A backup power supply within the module has sufficient power to continue to analyze the deceleration data and deploy restraint devices if needed, but there is no backup power for recording.

If the deceleration input does not create a vehicle longitudinal Delta-V above 4 mph within 100 milliseconds, there may not be any

data recorded.

2. In unusual circumstances, deceleration data stored in the module may be from a crash other than the one you are currently analyzing.
The module will record data from some non-deploy events. If, after the module has recorded data from a non-deploy event, and there is a subsequent event in which there is a loss of power and no new recording is made for that subsequent event, the deceleration data in the module's memory may be from the prior event. If the new, subsequent event is a deploy event and recording has occurred, the deployment times should be recorded. If there are no deployment times recorded, but airbags or other restraint devices are observed to have deployed, the recorded data that you read are most likely from a prior event.

Once an airbag or other restraint device has been commanded to deploy, the data recorded in connection with that deployment are "locked", and subsequent crashes cannot be recorded.

If a vehicle is being repaired, the RCM should be replaced after any crash in which restraint devices deploy. Early printed shop manuals refer to re-using modules by clearing the "crash data memory full" code, but this is no longer true and the latest on-line electronic shop manual directs that modules be replaced.

Crashes that involve multiple impacts will record only one of the impacts. If there is a deployment, the deployment event will be recorded and locked. If no restraint device is commanded to deploy, the recorded data are not "locked", and subsequent impacts may record over any previous recorded data. Further analysis will be required to determine which of the events was actually recorded.

3. The computed longitudinal Delta-V may understate the total Delta-V

Many real-world crashes can last longer than the memory has the capacity to record. Therefore, the actual Delta-V of the event may be higher than the Delta-V calculated and displayed by the Vetronix CDR System output. Review the end of the longitudinal acceleration/deceleration pulse - if it has not settled to zero G's by the end of the recording, the vehicle longitudinal Delta-V is most likely understated. If there is a clear decaying trend line you may choose, at your own risk, to estimate the total Delta-V by extrapolating the decay trend to zero and to calculate the additional Delta-V not captured.

Under some circumstances where power is interrupted, during the recording of data, or the module re-sets during the recording of data, a partial recording may occur. This will be shown as "no data" in the data table and will not be plotted on the graph of acceleration. The "no data" sections may be at the beginning, in the middle, or at the end(s) - it will not be consistent from one occurrence to another. When some portion of the acceleration data is not recorded, the Delta-V during that time cannot be calculated. A Delta-V will be calculated for the points that are valid, but the user must be aware that the partial Delta-V calculated will further underestimate the actual event total Delta-V. Restraint device deployment times are recorded first in to memory, and the acceleration data is recorded last. Thus, even with partial acceleration traces, deployment times are valid.

4. This module records only longitudinal acceleration/deceleration of the vehicle. You must compute lateral or resultant total acceleration based on your estimated Principal Direction of Force (PDOF).

5. Vertical acceleration/decelerations are not recorded. Vehicle spin about a point not centered on the Restraints Control Module sensor may add or subtract from bulk vehicle motion.

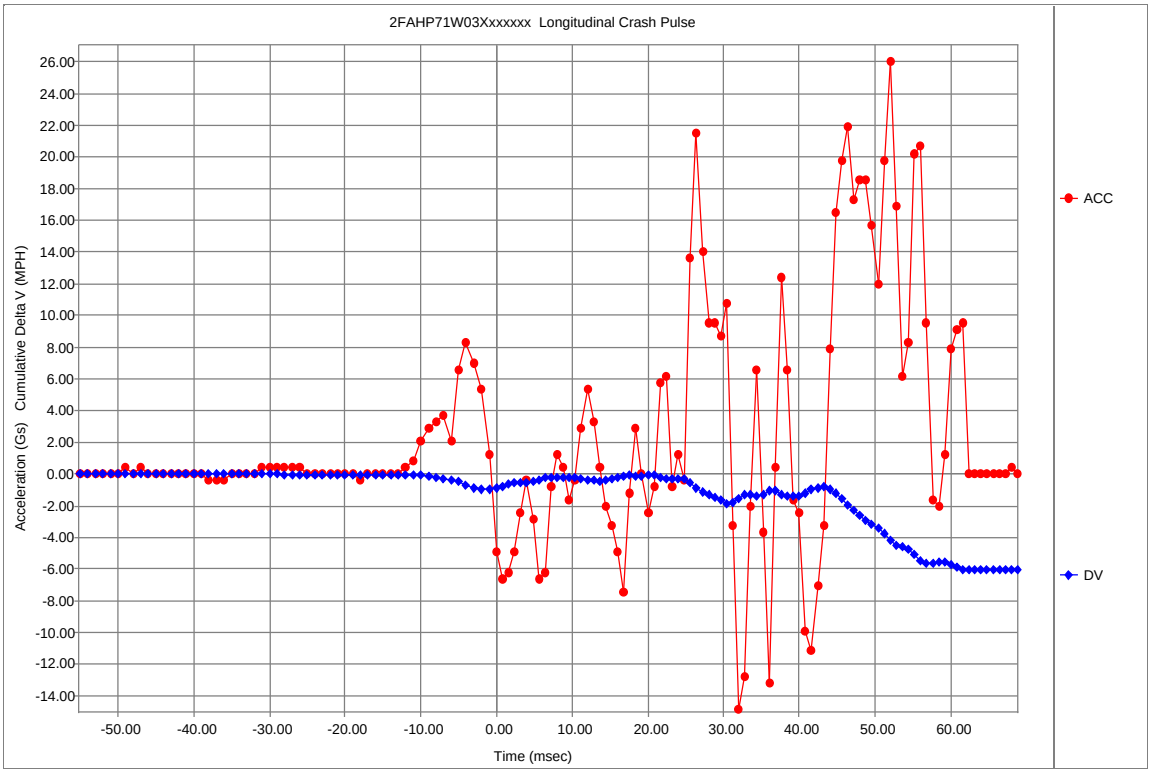
6. This module is not intended to record acceleration/deceleration in a side-impact event. If the side impact generates a longitudinal deceleration component sufficient to wake up the frontal deployment algorithm, there may be a recording of longitudinal deceleration in a side impact event.

Any Longitudinal Delta-V determined by using data read from the air bag module should be verified with physical evidence from the crash (such as vehicle crush, skid marks) and assumed accident sequence. Multiple impacts, angular collisions, side impacts, vehicle spin, etc should be considered in addition to the data read from the air bag module.

System Status At Deployment

Ford Part Number Prefix	3W7A
Number Of Active Faults	0
Driver Seat Belt Buckle	Buckled
Passenger Seat Belt Buckle	Unbuckled
Driver Seat Track In Forward Position	No
Occupant Classification Status Value	Off
Unbelted Stage 1	Fire
Unbelted Stage 2	Fire
Belted Stage 1	Fire
Belted Stage 2	Fire
Driver Pretensioner	Fire
Passenger Pretensioner	Fire

Parameter	Driver	Passenger
Pretensioner Time (milliseconds)	60	NONE
First Stage Time (milliseconds)	60	NONE
Second Stage Time (milliseconds)	69.6	NONE


2FAHP71W03Xxxxxxx Longitudinal Crash Pulse
Acceleration (Gs) Cumulative Delta V (MPH)
26.00
24.00
22.00
20.00
18.00
16.00
14.00
12.00
10.00
8.00
6.00
4.00
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
-14.00
-50.00
-40.00
-30.00
-20.00
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
Time (msec)
ACC
DV

Crash Pulse Data

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
-55.0	0.00	0.00
-54.0	0.00	0.00
-53.0	0.00	0.00
-52.0	0.00	0.00
-51.0	0.00	0.00
-50.0	0.00	0.00
-49.0	0.41	-0.01
-48.0	0.00	-0.01
-47.0	0.41	-0.02
-46.0	0.00	-0.02
-45.0	0.00	-0.02
-44.0	0.00	-0.02
-43.0	0.00	-0.02
-42.0	0.00	-0.02
-41.0	0.00	-0.02
-40.0	0.00	-0.02
-39.0	0.00	-0.02
-38.0	-0.41	-0.01
-37.0	-0.41	0.00
-36.0	-0.41	0.01
-35.0	0.00	0.01
-34.0	0.00	0.01
-33.0	0.00	0.01
-32.0	0.00	0.01
-31.0	0.41	0.00
-30.0	0.41	-0.01
-29.0	0.41	-0.02
-28.0	0.41	-0.03
-27.0	0.41	-0.04
-26.0	0.41	-0.05
-25.0	0.00	-0.05
-24.0	0.00	-0.05
-23.0	0.00	-0.05
-22.0	0.00	-0.05
-21.0	0.00	-0.05
-20.0	0.00	-0.05
-19.0	0.00	-0.05
-18.0	-0.41	-0.04
-17.0	0.00	-0.04
-16.0	0.00	-0.04
-15.0	0.00	-0.04
-14.0	0.00	-0.04
-13.0	0.00	-0.04
-12.0	0.41	-0.05
-11.0	0.83	-0.06
-10.0	2.06	-0.11
-9.0	2.89	-0.17
-8.0	3.30	-0.24
-7.0	3.72	-0.33
-6.0	2.06	-0.37
-5.0	6.61	-0.52

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
-4.0	8.26	-0.70
-3.0	7.02	-0.85
-2.0	5.37	-0.97
-1.0	1.24	-1.00
0.0	-4.95	-0.89
0.8	-6.61	-0.77
1.6	-6.19	-0.66
2.4	-4.95	-0.58
3.2	-2.48	-0.53
4.0	-0.41	-0.53
4.8	-2.89	-0.47
5.6	-6.61	-0.36
6.4	-6.19	-0.25
7.2	-0.83	-0.24
8.0	1.24	-0.26
8.8	0.41	-0.26
9.6	-1.65	-0.24
10.4	-0.41	-0.23
11.2	2.89	-0.28
12.0	5.37	-0.37
12.8	3.30	-0.43
13.6	0.41	-0.44
14.4	-2.06	-0.40
15.2	-3.30	-0.34
16.0	-4.95	-0.26
16.8	-7.43	-0.13
17.6	-1.24	-0.11
18.4	2.89	-0.16
19.2	0.00	-0.16
20.0	-2.48	-0.11
20.8	-0.83	-0.10
21.6	5.78	-0.20
22.4	6.19	-0.31
23.2	-0.83	-0.29
24.0	1.24	-0.32
24.8	-0.41	-0.31
25.6	13.63	-0.55
26.4	21.47	-0.92
27.2	14.04	-1.17
28.0	9.50	-1.34
28.8	9.50	-1.50
29.6	8.67	-1.66
30.4	10.74	-1.84
31.2	-3.30	-1.79
32.0	-14.86	-1.53
32.8	-12.80	-1.30
33.6	-2.06	-1.26
34.4	6.61	-1.38
35.2	-3.72	-1.32
36.0	-13.21	-1.08
36.8	0.41	-1.09
37.6	12.39	-1.31
38.4	6.61	-1.42
39.2	-1.65	-1.39

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
40.0	-2.48	-1.35
40.8	-9.91	-1.18
41.6	-11.15	-0.98
42.4	-7.02	-0.86
43.2	-3.30	-0.80
44.0	7.85	-0.94
44.8	16.52	-1.23
45.6	19.82	-1.58
46.4	21.88	-1.96
47.2	17.34	-2.26
48.0	18.58	-2.59
48.8	18.58	-2.92
49.6	15.69	-3.19
50.4	11.97	-3.40
51.2	19.82	-3.75
52.0	26.01	-4.21
52.8	16.93	-4.50
53.6	6.19	-4.61
54.4	8.26	-4.76
55.2	20.23	-5.11
56.0	20.65	-5.47
56.8	9.50	-5.64
57.6	-1.65	-5.61
58.4	-2.06	-5.58
59.2	1.24	-5.60
60.0	7.85	-5.74
60.8	9.08	-5.89
61.6	9.50	-6.06
62.4	0.00	-6.06
63.2	0.00	-6.06
64.0	0.00	-6.06
64.8	0.00	-6.06
65.6	0.00	-6.06
66.4	0.00	-6.06
67.2	0.00	-6.06
68.0	0.41	-6.07
68.8	0.00	-6.07

Hexadecimal Data

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

```
0000:  94 BB FE 03 A5 42 20 A9 0E 22 0E 2B 38 55 18 1E
0010:  00 7D 0C 19 0C 19 05 CC 33 57 37 41 04 00 71 7D
0020:  07 03 CC 72 45 33 31 32 30 33 43 31 37 33 31 32
0030:  39 34 31 32 37 33 31 32 39 33 38 35 33 33 31 31
0040:  38 43 36 43 68 66 77 69 03 60 30 27 17 00 04 00
0050:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0060:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0070:  00 00 00 00 00 00 01 00 00 00 00 00 00 00 00 00
0080:  33 01 75 71 72 75 7B 80 7A 71 72 7F 84 82 7D 80
0090:  88 8E 89 82 7C 79 75 6F 7E 88 81 7B 7F 8F 90 7F
00A0:  84 80 A2 B5 A3 98 98 96 9B 79 5D 62 7C 91 78 61
00B0:  82 9F 91 7D 7B 69 66 70 79 94 A9 B1 B6 AB AE AE
00C0:  A7 9E B1 C0 AA 90 95 B2 B3 98 7D 7C 84 94 97 98
00D0:  81 81 81 81 81 81 81 82 81 82 81 81 81 81 81 81
00E0:  81 81 80 80 80 81 81 81 81 82 82 82 82 82 82 81
00F0:  81 81 81 81 81 81 80 81 81 81 81 81 82 83 86 88
0100:  89 8A 86 91 95 92 8E 84 01 00 1B 36 F4 F6 00 4B
0110:  00 57 00 00 00 00 00 4B 00 00 00 32 1A 1C 00 00
0120:  1A 00 00 43 00 00 00 00 00 56 00 56 4F 4E 81 20
0130:  20 CC FF 03 02 6C 05 0F 05 05 02 6C 07 43 09 AE
0140:  01 02 01 01 05 07 05 05 03 05 05 0B 00 00 00 3D
0150:  00 00 01 2F 00 79 00 00 00 C2 04 D7 00 B3 01 A8
0160:  01 E4 00 C4 00 A0 01 C0 00 44 01 DF 00 F9 00 63
0170:  FF FE 03 D2 2F 44 2F 44 2F 44 02 25 01 F3 01 6D
0180:  01 DF 02 25 FF FE 00 BF FF FE 05 63 00 85 00 85
0190:  FF FE 00 6D FF FE FF FE 00 94 00 30 00 BD 00 BD
01A0:  00 00 07 02 0A 02 02 6C 04 D7 13 5C 09 AE 3D 00
01B0:  00 01 03 04 03 06 04 06 05 04 00 63 00 C2 00 79
01C0:  01 83 00 C2 00 3D 00 49 00 91 09 AE 01 F0 00 2C
01D0:  00 63 00 C6 00 63 00 F7 00 63 00 A2 00 50 01 3F
01E0:  FF FE 02 2F 01 0D 00 94 01 0D 01 E9 01 8F 00 C6
01F0:  02 A6 01 0D 01 3F 07 06 01 DF 00 C6 1F 00 2F A5
```

Attachment B
EDR Report – 2002 Chevrolet Trailblazer

CDR File Information

Vehicle Identification Number	1GNDT13S922xxxxxx
Investigator	
Case Number	CA04-002
Investigation Date	1/23/04
Crash Date	1/17/04
Filename	CA04-002 TRAILBLAZER.CDR
Saved on	1/23/2004 10:24:33 AM
Data check information	D984C95
Collected with CDR version	Crash Data Retrieval Tool 2.00
Collecting program verification number	A31D1C76
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	Non-Deployment

SDM Data Limitations

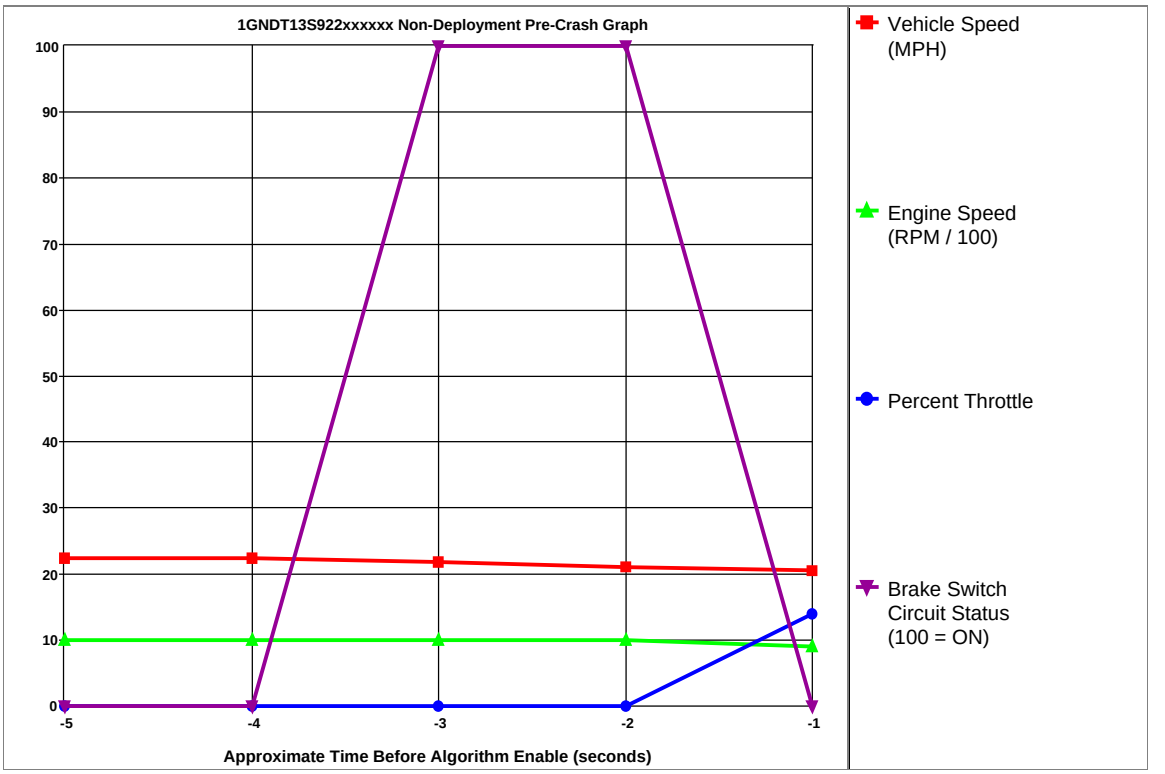
SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event can be overwritten by an event that has a greater SDM recorded vehicle forward velocity change. This event will be cleared by the SDM after the ignition has been cycled 250 times.
The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. Deployment events can not be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the non-deployment file will be locked after a deployment, if the non-deployment occurred within 5 seconds before the deployment or a deployment level event occurs within 5 seconds after the deployment.

SDM Data Limitations:
-SDM Recorded Vehicle Forward Velocity Change is one of the measures used to make air bag deployment decisions. SDM Recorded Vehicle Forward Velocity Change reflects the change in forward velocity that the sensing system experienced during the recorded portion of the event. SDM Recorded Vehicle Forward Velocity Change is the change in velocity during the recording time and is not the speed the vehicle was traveling before the event, and is also not the Barrier Equivalent Velocity. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. For deployments and deployment level events, the SDM will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. For non-deployments, the SDM will record the first 150 milliseconds of data after algorithm enable.
-Event Recording Complete will indicate if data from the recorded event has been fully written to the SDM memory or if it has been interrupted and not fully written.
-SDM Recorded Vehicle Speed accuracy can be affected if the vehicle has had the tire size or the final drive axle ratio changed from the factory build specifications.
-Brake Switch Circuit Status indicates the status of the brake switch circuit.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if the SDM does not receive a valid message.
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit
-The Time Between Non-Deployment and Deployment Events is displayed in seconds. If the time between the two events is greater than 25.4 seconds, "N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.

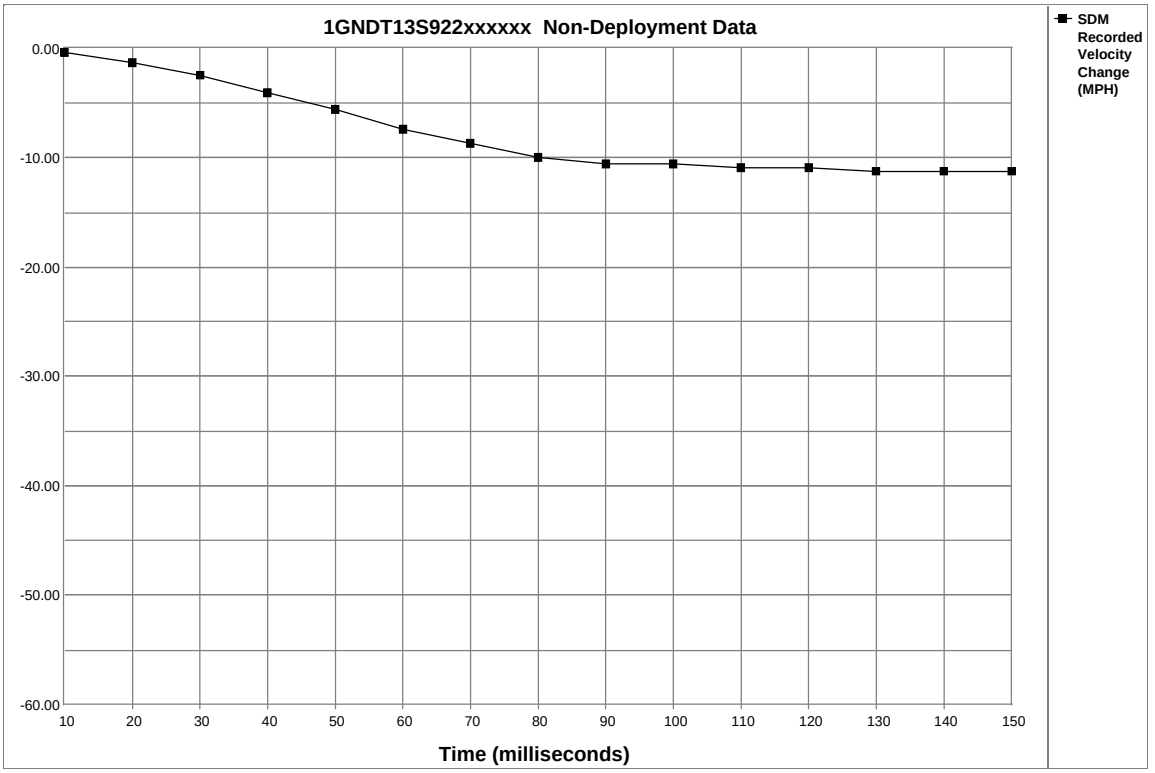
SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the Class 2 data link, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the Class 2 data link, to the SDM.
-In most vehicles, the Driver's Belt Switch Circuit is wired directly to the SDM. In some vehicles, the Driver's Belt Switch Circuit Status data is transmitted from the Body Control Module (BCM), via the Class 2 data link, to the SDM.

System Status At Non-Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Ignition Cycles At Non-Deployment	6319
Ignition Cycles At Investigation	6324
Maximum SDM Recorded Velocity Change (MPH)	-11.37
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	130
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	22	1024	0	OFF
-4	22	960	0	OFF
-3	22	960	0	ON
-2	21	960	0	ON
-1	21	896	14	OFF



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.31	-1.24	-2.48	-4.03	-5.58	-7.44	-8.68	-9.92	-10.54	-10.54	-10.85	-10.85	-11.16	-11.16	-11.16

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  08 31 46 B7 AE FB
$02  D1 D1 38 38 00 00
$03  41 53 32 30 34 35
$04  4B 38 42 57 33 31
$06  15 08 08 60 00 00
$10  FC E9 F0 00 00 00
$11  7D 7C 7D 7C 7C 7C
$12  B1 00 00 00 00 00
$13  35 00 00 00 00 00
$14  1D 1D 05 05 00 00
$15  FA FA FA FA FA FA
$16  FA FA FA FA FA FA
$17  FA FA 00 00 00 00
$18  3F 00 55 AC 01 00
$1F  FF 00 00 00 00 00
$20  12 FE 00 00 FF FF
$21  FF FF FF FF FF FF
$22  FF FF FF FF FF FF
$23  FF FF FF FF FF FF
$24  00 02 4A 2E 34 47
$25  23 00 00 00 FF FF
$26  01 04 08 0D 12 18
$27  1C 20 22 22 23 23
$28  24 24 24 00 FC EA
$29  80 A5 FF FF FF FF
$2A  FF FF FF FF FF FF
$2B  FF FF FF FF FF FF
$2C  FF FF FF FF FF FF
$2D  FF FF 00 00 00 00
$30  FF FF FF FF FF FF
$31  FF FF FF FF FF FF
$32  FF FF FF FF FF FF
$33  FF FF FF FF FF FF
$34  FF FF FF FF FF FF
$35  FF FF FF FF FF FF
$36  FF FF FF FF FF FF
$37  FF FF FF FF FF FF
$38  FF FF FF FF FF FF
$39  FF FF FF FF FF FF
$3A  FF FF FF FF FF FF
$3B  FF FF FF FF FF FF
$3C  FF FF FF FF FF FF
$3D  FF FF 00 00 00 00
$40  21 22 23 24 24 00
$41  61 00 24 00 00 00
$42  00 00 0E 0F 0F 0F
$43  10 00 7D 80 00 00
$44  FF FF FF FF FF FF
$45  FF FF FF FF FF FF
$46  FF FF FF FF FF FF
$47  FF FF FF FF 00 00
$48  FF FF FF FF FF FF
$49  FF FF FF FF FF FF
$4A  FF FF FF FF FF FF
$4B  FF FF FF FF 00 00
$4C  FF FF FF FF FF FF
$4D  FF FF FF FF FF FF
$4E  FF FF FF FF FF FF
$4F  FF FF FF FF 00 00
$50  FF FF FF FF FF FF
$51  FF FF FF FF FF FF
$52  FF FF FF FF FF FF
```

$53 FF FF FF FF FF FF
$54 FF FF FF FF FF FF