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ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM INVESTIGATION

CASE NUMBER - IN-02-007
LOCATION - Texas
VEHICLE - 2001 FORD CROWN VICTORIA
CRASH DATE - September 2002

Submitted:
August 8, 2003
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Prepared for:

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National Highway Traffic Safety Administration
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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 be 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 Documentation Page

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15. Supplementary Notes
On-site investigation involving a 2001 Ford Crown Victoria equipped with multiple advanced occupant protection systems, and a 1995 Dodge Intrepid.

16. Abstract
This on-site investigation concerns an air bag deployment crash involving a 2001Ford Crown Victoria Police Interceptor (case vehicle) and a 1995 Dodge Intrepid (other vehicle). This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection Systems as well as an Event Data Recorder and the case vehicle's unrestrained driver (33-year-old male) sustained moderate injuries as a result of the crash. There were no other occupants in the case vehicle. The case vehicle was traveling northwest in the second northwestbound through lane of a four-lane roadway that was part of a divided trafficway, approaching a three-leg intersection and intending to pass through and continue northwest. The other vehicle had been traveling southeast in the southeastbound left turn lane of the same trafficway and turned left to travel northeast on the intersecting city street. The front left of the case vehicle impacted the right front area of the other vehicle, causing the case vehicle's driver and front right passenger air bags to deploy. The other vehicle was also equipped with dual front air bags that did deploy. The case vehicle rotated clockwise while the other vehicle rotated counterclockwise and the two vehicles side slapped, with the left back of the case vehicle impacting the right back of the other vehicle. The case vehicle mounted the curb at the northeast corner of the intersection, sustaining left and right front wheel impacts, traveled along the lawn of a commercial building and came to rest heading northwest. Both vehicles were towed due to disabling damage. The case vehicle driver was transported to a hospital via ambulance, where he was admitted for treatment and observation for two days. His injuries included : fractures of the right patella and right scapula; a concussion with brief unconsciousness; contusions and abrasions on his face; and various minor soft tissue injuries.

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Air Bag Deployment	Motor Vehicle Traffic Crash	General Public
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BACKGROUND

This on-site investigation was brought to the NHTSA's attention on October 22, 2002 by NASS/GES sampling activities. The crash involved a 2001 Ford Crown Victoria Police Interceptor (case vehicle) and a 1995 Dodge Intrepid ES (other vehicle). The crash occurred in September 2002 at 4:00 a.m. in Texas and was investigated by the applicable municipal police agency. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection Systems (AOPS) as well as an Event Data Recorder (EDR) and the case vehicle's unrestrained driver (33-year-old male, white, non-Hispanic) sustained moderate injuries as a result of the crash. There were no other occupants in the case vehicle. The scene and case vehicle were inspected on October 29, 2002, and the EDR was harvested and forwarded to Ford to be downloaded. The other vehicle was inspected and the case vehicle driver was interviewed on October 30. This report is based on the police crash report, scene and vehicle inspections, the interview with the case vehicle driver, the driver's medical records, occupant kinematic principles and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling northwest in the second northwestbound through lane of a four-lane roadway that was part of a divided trafficway, approaching a three-leg intersection and intending to pass through and continue northwest. The other vehicle had been traveling southeast in the southeastbound left turn lane of the same trafficway and turned left to travel northeast on the intersecting city street. Based on the police crash report, the case vehicle driver braked, depositing 49.7 meters [163 feet] of pre-crash skid marks, and probably steered slightly to the right. The police reconstructionists estimated that the case vehicle was traveling at a minimum speed of 106 km.p.h. [66 m.p.h.] prior to the pre-crash braking. The crash occurred on the northwestbound roadway, within the intersection.

The front left of the case vehicle impacted the right front area of the other vehicle, causing the case vehicle's driver and front right passenger air bags to deploy. The other vehicle was also equipped with dual front air bags that deployed. The case vehicle rotated clockwise while the other vehicle rotated counterclockwise and the two vehicles side slapped, with the left back of the case vehicle impacting the right back of the other vehicle. The case vehicle mounted the curb at the northeast corner of the intersection, sustaining left and right front wheel impacts, traveled approximately 26 meters [85 feet] along the lawn of a commercial building and came to rest heading northwest. The other vehicle was redirected northwestward by the side slap impact and slid to rest in the curb lane with its rear wheels against the curb, heading west.

The case vehicle was a rear wheel drive 2001 Ford Crown Victoria Police Interceptor four-door, six passenger sedan (VIN: 2FAFP71W81X------), equipped with 4.6 liter V8 gasoline engine and an automatic transmission with a column-mounted selector lever. The case vehicle was not equipped with anti-lock brakes. Its odometer reading was 23,795 kilometers [14,786 miles] and its wheelbase was 291 centimeters [114.7 inches]. The case vehicle was equipped with multiple advanced occupant protection systems, including dual stage air bag inflators, pretensioners for the two front outboard seat positions, driver seat track sensor, and an EDR.

The case vehicle sustained direct contact damage across the left two-thirds of the front from the first impact with the other vehicle, with induced damaged across the entire front and additional damage on the left fender resulting as the two vehicles rotated into each other. The front left corner area was crushed rearward and inward, with the radiator and other above-bumper front components crushed rearward, more heavily on the left. The grille and both headlamp assemblies were shattered and the front bumper cover was torn across the entire width with pieces missing. The steel bumper was separated from its mounting on the left. Maximum crush on the front plane was 69 centimeters [27.2 inches] at the front left corner. The left rear corner of the hood impacted the lower left corner of the windshield, causing heavy cracking of the laminated windshield. The left A-pillar was displaced rearward, the left front door opening was distorted and there was buckling of the left roof rail near the B-pillar. The driver's door came open, with the latch mechanism visibly damaged. The case vehicle's wheelbase was shortened by 30 centimeters [11.8 inches] on the left and 3 centimeters [1.2 inches] on the right. The CDC for the front impact was determined to be **11-FDEW-3 (340)**. The WinSMASH reconstruction program was used on the case vehicle's most severe impact, based on the measured crush profile for both vehicles. The results indicate Total, Longitudinal and Lateral DeltaV's for the case vehicle, respectively: 23.0 km.p.h. [14.3 m.p.h.], -21.6 km.p.h. [-13.4 m.p.h.] and +7.9 km.p.h. [+4.9 m.p.h.]. These results appear somewhat low.

The case vehicle also sustained direct damage on the left rear quarter panel from the second (side slap) event. The case vehicle's high pre-crash speed and lock-up braking caused its front to be angled down and its rear wheels were probably raised up off the ground as the case vehicle pivoted clockwise into the side slap impact. Direct contact was measured as 65 centimeters [25.6 inches], centered on the rear overhang. Maximum crush was 17 centimeters [6.7 inches]. The CDC was determined to be **09-LBEW-2 (270)**. The WinSMASH reconstruction program was used on this secondary impact, based on the measured crush profiles of both vehicles. The results for the case vehicle indicate Total, Longitudinal and Lateral DeltaVs for the case vehicle, respectively: 8.0 km.p.h. [5.0 m.p.h.], 0 km.p.h. [0 m.p.h.] and +8.0 km.p.h. [+5.0 m.p.h.]. The case vehicle also sustained left and right front wheel impacts as it mounted the curb, with CDCs **12-FLWN-3** and **12-FRWN-3**.

Inspection of the case vehicle's interior revealed several areas of intrusion and evidence of occupant contact. The toe pan in driver's foot well was moved 21 centimeters [8.3 inches] rearward. The left side instrument panel was moved 13 centimeters [5.1 inches] rearward, with the steering assembly displaced 6 centimeters [2.4 inches] upward and the upper half of the steering wheel rim bent 2 centimeters [0.8 inches] forward. The lower end of the left upper A-pillar was moved 4 centimeters [1.6 inches] rearward. There was an imprint and dent in the knee bolster below the steering column. There was also a skin transfer in the fractured windshield.

The case vehicle was equipped with driver and front right passenger front air bags. The driver's air bag was mounted in the steering wheel hub, with a single module cover flap. The cover flap opened at the tear points, with no evidence of damage to the flap, the adjacent structures or the air bag. The driver's air bag was round, with diameter 56 centimeters [22.0 inches]. There were droplets of blood in the 9 o'clock region on the front, extending to the back of the air bag and no other evidence of contact.

The front right passenger air bag was located in the mid-instrument panel position, with a single module cover flap. The cover flap opened at the tear points, with no evidence of damage to the cover flap, the adjacent structures or the air bag. The front right passenger's air bag was rectangular, measuring 51 centimeters [20.1 inches] vertically and 53 centimeters [20.9 inches] horizontally. Inspection of the air bag revealed scuff marks from the deployment and no other evidence of contact.

The Event Data Recorder (EDR) was harvested during the inspection and forwarded to Ford to be downloaded. The EDR device and associated software were under development and the analysts found that the downloaded data were incomplete. The Restraints Control Module System Status report indicates that the case vehicle was equipped with dual stage air bags and safety belt pretensioners at the driver and front right passenger seat positions. The available data indicate that the driver's and passenger's safety belts were not buckled and the driver's seat track was not at the full forward position. The report indicates that the driver's and front right passenger's air bags deployed at the Stage One level while Stage Two did not deploy. The report also indicates that the driver's and front right passenger's safety belt pretensioners did not actuate.

The case vehicle driver (33-year-old male, white, non-Hispanic, 183 centimeters, 82 kilograms [72 inches, 180 pounds]) was not restrained by the available, manual, three-point lap-and-shoulder safety belt system. Inspection of the driver's safety belt system components did not reveal any signs of loading. In addition, the driver's injuries did not include any abrasions or contusions on his chest, hips or abdomen. The case vehicle was equipped with pretensioners at the two front seat outboard positions that did not actuate.

The case vehicle driver was seated in a normal driving posture, with his back against the seat back, his left foot on the floor, his right foot operating the foot controls and both hands on the steering wheel. The seat back was adjusted at the upright position and the seat track was adjusted full rearward. The tilt steering wheel was adjusted between the center and full down position. He was wearing a belt with various items of police equipment on it.

The driver observed the other vehicle turning left across his path and braked with full lock-up. As a result of the braking, the driver moved forward immediately prior to the impact. When the case vehicle impacted the other vehicle, the driver moved further forward, upward and slightly leftward, toward the 340 degree direction of force. Because he had already moved forward in response to the braking deceleration, the driver air bag deployed against his face and chest causing an abrasion on his forehead and bruising around his left eye. He lost his grip on the steering wheel and his hands flailed forward, striking the windshield and fracturing it, and causing lacerations on the knuckles of his right hand. His left arm encountered the air bag, causing bruising in the area above and below his left elbow. His own weight prevented the air bag from expanding outward and the combination of the air bag and his inertial force caused the top of the steering wheel rim to bend forward. His right knee impacted the knee bolster immediately below the steering column, causing a fracture of his right patella (knee cap). He had been bearing down on the brake pedal and sustained extensive bruising on the bottom of his right foot. As the case vehicle rotated clockwise, he rebounded rearward and was forcefully thrown to the right. His right shoulder area probably impacted the inboard edge of the driver's bucket seat back and he sustained a fracture of his right scapula, and he sustained bruising in the small of his back, probably from the equipment on his police belt. The side slap impact caused him to move to the left, and he remained in the seat as the vehicle slid to final rest.

The other vehicle was a front wheel drive 1995 Dodge Intrepid four-door, five passenger sedan (VIN: 1B3HD56FX3F------), equipped with a 3.5 liter V-6 gasoline engine and an automatic transmission with a column-mounted selector lever. Four wheel anti-lock brakes were an option for this model, but it is not known if this vehicle was so equipped. The odometer reading is not known. Its wheelbase was 287 centimeters [113.0 inches]. The Dodge was towed due to disabling damage.

The Dodge sustained initial direct contact at the right front corner area that was measured as 91 centimeters [35.8 inches]. As the two vehicles rotated into each other, the entire right front fender sustained crushing and abrading. Maximum crush was measured as 61 centimeters [24.0 inches] at the right front corner. The CDC for the first impact was determined to be **02-RYEW-4 (80)**. The WinSMASH reconstruction program was used on the Dodge's most severe impact, based on the measured crush profile of both vehicles. The Total, Longitudinal and Lateral Delta-V's are, respectively: 32.0 km.p.h. [19.9 m.p.h.], -10.9 km.p.h. [-6.8 m.p.h.] and -30.1 km.p.h. [-18.7 m.p.h.]. These results appear to be low.

The Dodge also sustained direct contact on its right rear quarter panel from the side slap impact (event #2) with the case vehicle. Because of its high speed and configuration at the first impact, the case vehicle's rear wheels were probably raised up off the ground as the two vehicles pivoted into each other. As a result of the case vehicle being elevated, direct damage on the Dodge was restricted to the upper portion of the quarter panel and trunk lid. The CDC for the side slap impact was determined to be **03-RBMW-3 (90)**. The WinSMASH reconstruction for this second impact indicated Total, Longitudinal and Lateral Delta-V's, respectively: 10.0 km.p.h. [6.2 m.p.h.], 0 km.p.h. [0 m.p.h.] and -10 km.p.h. [-6.2 m.p.h.].

CRASH CIRCUMSTANCES

The case vehicle was traveling northwest in the second northwestbound through lane of a four-lane roadway that was part of a divided trafficway, approaching an uncontolled, perpendicular, three-leg intersection and intending to pass through and continue northwest. The intersecting roadway was a two-lane local road that joined from the right (northeast). The crash occurred during the hours of darkness, but the roadway was illuminated by overhead lights. The asphalt road surface was dry and free of defects, the weather was clear and the posted speed limit was 64 km.p.h. [40 m.p.h.]. The paved surface measured 12.6 meters [41.3 feet] from the median to the curb. The curb lane on the northwestbound roadway was a bus lane, separated from the other travel lanes by a painted, solid, double white line. The other vehicle had been traveling southeast in the southeastbound left turn lane of the same trafficway and turned left to travel northeast on the intersecting city street. Based on the police crash report, the case vehicle driver braked, depositing 49.7 meters [163 feet] of pre-crash skid marks, and probably steered slightly to the right. The case vehicle driver could not provide an estimate of his pre-crash travel speed. The police reconstructionists estimated that the case vehicle was traveling at a minimum speed of 106 km.p.h. [66 m.p.h.] prior to the pre-crash braking. The crash occurred on the northwestbound roadway, within the intersection (**Figure 1**).

The front left of the case vehicle impacted the right front area of the other vehicle, causing the case vehicle's driver and front right passenger air bags to deploy. The other vehicle was also equipped with dual front air bags that did deploy. The case vehicle was rotated clockwise while the other vehicle rotated counterclockwise. The two vehicles side slapped, with the left back of the case vehicle impacting the right back of the other vehicle. The case vehicle mounted the curb at the northeast corner of the intersection, sustaining left and right front wheel impacts, departed the roadway at the northeast corner of the intersection, traveled approximately 26 meters [85 feet] along the lawn of a commercial building and came to rest heading northwest. The other vehicle was redirected northwestward by the side slap impact and slid to rest in the bus lane with its rear wheels against the curb, heading west.

Figure 1: Case vehicle's northwestbound approach toward impact within the intersection; the other vehicle was approximately at the location of the vehicle in the center of this photograph (case photo #03)

CASE VEHICLE

The case vehicle was a rear wheel drive 2001 Ford Crown Victoria Police Interceptor four-door, six passenger sedan (VIN: 2FAFP71W81X------), equipped with 4.6 liter V8 gasoline engine and an automatic transmission with a column-mounted selector lever. The case vehicle was equipped with multiple advanced occupant protection systems, including dual stage air bag inflators, pretensioners for the two front outboard seat positions driver seat track sensor, and an EDR. The case vehicle was not equipped with anti-lock brakes. Its odometer reading was 23,795 kilometers [14,786 miles] and its wheelbase was 291 centimeters [114.7 inches]. The case vehicle was towed due to disabling damage.

Figure 2: Case vehicle's front left damage from first (most severe) impact; note wheel damage from curb impact, front right wheel also damaged (case photo #18)

Case Vehicle Damage

Figure 3: Front of case vehicle (case photo #14)

The case vehicle sustained direct contact damage across the left two-thirds of the front from the first impact, with induced damaged across the entire front and additional damage on the left fender resulting as the two vehicles rotated into each other (**Figures 2** and **3**). The front left corner area was crushed rearward and inward, with the radiator and other above-bumper front components displaced rearward. The grille and both headlamp assemblies were shattered and the front bumper cover was torn across the entire width with pieces missing. The steel bumper was separated from its mounting on the left. Maximum crush on the front plane was 69 centimeters [27.2 inches] at the front left corner. The left rear corner of the hood impacted the lower left corner of the windshield, causing heavy cracking of the laminated windshield. The left A-pillar was displaced rearward, the left front door opening was distorted and there was buckling of the left roof rail near the B-pillar. The driver's door came open, with the latch mechanism visibly damaged. The case vehicle's wheelbase was shortened by 30 centimeters [11.8 inches] on the left and 3 centimeters [1.2 inches] on the right. The CDC for the front impact was determined to be **11-FDEW-3 (340)**. The WinSMASH reconstruction program was used on the case vehicle's most severe impact, based on the measured crush profile for both vehicles. The results indicated Total, Longitudinal and Lateral Delta-V's, respectively: 23.0 km.p.h. [14.3 m.p.h.], -21.6 km.p.h. [-14.1 m.p.h.] and +7.9 km.p.h. [+4.9 m.p.h.]. These results appear somewhat low.

Figure 4: Side slap damage on case vehicle's left rear quarter panel (case photo #20)

The case vehicle also sustained direct damage on the left rear quarter panel from the second (side slap) event (**Figure 4**). The case vehicle's high pre-crash speed and lock-up braking caused its front to be angled down and its rear wheels probably lifted up off the ground as the case vehicle pivoted clockwise into the side slap impact. Direct contact was measured as 65 centimeters [25.6 inches], centered on the rear overhang. The left tail light lens was broken out and the trunk lid was displaced. Maximum crush was 17 centimeters [6.7 inches]. The CDC was determined to be **09-LBEW-2 (270)**. The WinSMASH reconstruction program was used on this secondary impact, based on the measured crush profiles of both vehicles. The results indicated Total, Longitudinal and Lateral DeltaVs, respectively: 8.0 km.p.h. [5.0 m.p.h.], 0 km.p.h. [0 m.p.h.] and +8.0 km.p.h. [+5.0 m.p.h.]. These results appear reasonable. The case vehicle also sustained left and right front wheel impacts as it mounted the curb, with CDCs **12-FLWN-3** and **12-FRWN-3**.

Inspection of the case vehicle's interior revealed several areas of intrusion and evidence of occupant contact. The toe pan in driver's foot well was moved 21 centimeters [8.3 inches] rearward (**Figure 5**). The left side instrument panel was moved 13 centimeters [5.1 inches] rearward, with the steering assembly displaced 6 centimeters [2.4 inches] upward and the upper half of the steering wheel rim bent 2 centimeters [0.8 inches] forward. The lower end of the left upper A-pillar was moved 4 centimeters [1.6 inches] rearward. There was an imprint and dent in the knee bolster below the steering column. There was also a skin transfer in the fractured windshield.

Figure 5: Intrusion into case vehicle driver's foot well area (case photo #37)

CASE VEHICLE AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with driver and front right passenger front air bags. The driver's air bag (**Figure 6**) was mounted in the steering wheel hub, with a single module cover flap that measured 12 centimeters [4.7 inches] vertically and 15 centimeters [5.9 inches] horizontally, with the top edge tapering to a hinge that measured 9 centimeters [3.5 inches] horizontally. The cover flap opened at the tear points, with no evidence of damage to the flap, the adjacent structures or the air bag. The driver's air bag was round, with diameter 56 centimeters [22.0 inches]. It had four tethers that were 6 centimeters [2.4 inches] wide, and two vent ports each with a diameter of 3 centimeters [1.2 inches] at the 11:00 and 1:00 o'clock positions. There were droplets of blood in the 9:00 o'clock region on the front extending to the back of the air bag and no other evidence of contact.

Figure 6: Front of case vehicle driver's air bag (top of bag at left in this photo); note blood drops (highlighted) in the 9 o'clock region (case photo #48)

The front right passenger air bag was located in the mid-instrument panel position (**Figure 7**), with a single module cover flap that measured 40 centimeters [15.7 inches] horizontally and 15 centimeters [5.9 inches] vertically. The cover flap opened at the tear points, with no evidence of damage to the cover

Figure 7: Front of case vehicle's front right passenger's air bag (case photo #49)

flap, the adjacent structures or the air bag. The front right passenger's air bag was rectangular, measuring 51 centimeters [20.1 inches] vertically and 53 centimeters [20.9 inches] horizontally. It was designed with no tether strap and a single vent port with a diameter of 7 centimeters [2.8 inches] at the 8 o'clock position on the back. Inspection of the air bag revealed scuff marks from the deployment and no other evidence of contact.

CASE VEHICLE EVENT DATA RECORDER

The Event Data Recorder (EDR) was harvested during the inspection and forwarded to Ford to be downloaded. The EDR device and associated software were in development and the analysts found that the downloaded data were incomplete. In addition, it appears that electrical power to the EDR was interrupted such that the device stopped recording after approximately 29 milliseconds [0.029 seconds]. The full text of the EDR report is included as Appendix A.

The System Status at Deployment report (Appendix A, page 3 of 8) indicates that there were no faults in the automatic restraint system. The case vehicle was equipped with dual stage air bags and safety belt pretensioners at the driver and front right passenger seat positions. The available data indicate that the driver's and passenger's safety belts were not buckled and the driver's seat track was not at the full forward position. The System Status report indicates that the impact forces were of sufficient magnitude to satisfy the criteria for unbelted and belted Stage 1 deployment for the driver's and front right passenger's air bags, but the threshold for Stage 2 deployment was not attained. In addition, the criterion for actuation of the safety belt pretensioners was met.

The table of system Parameters (Appendix A, page 3 of 8) shows that the pretensioners did not actuate (because the safety belt buckles were not latched, i.e., not in use). Stage 1 deployment of the air bags occurred at 11.2 milliseconds [0.0112 seconds] after algorithm enable. The propellant for Stage 2 deployment was discarded at 111.2 milliseconds [0.1112 seconds] after algorithm enable.

The graph of the longitudinal crash pulse (Appendix A, page 4 of 8) and the table of Longitudinal Crash Pulse Data (Appendix A, page 6 of 8) show that the maximum recorded change in longitudinal velocity was -8.5 km.p.h. [-5.27 m.p.h.] at 28.8 milliseconds [0.0288 seconds] after algorithm enable, but the device stopped recording after that moment.

CASE VEHICLE DRIVER KINEMATICS

The case vehicle driver (33-year-old male, white, non-Hispanic, 183 centimeters, 82 kilograms [72 inches, 180 pounds]) was not restrained by the available, manual, three-point lap-and-shoulder safety belt system. Inspection of the driver's safety belt system components did not reveal any signs of loading. In addition, the driver's description of his injuries did not include any abrasions or contusions on his chest, hips or abdomen. The case vehicle was equipped with retractor pretensioners at the two front seat outboard positions that did actuate.

The case vehicle driver was seated in a normal driving posture, with his back against the seat back, his left foot on the floor, his right foot operating the foot controls and both hands on the steering wheel. The seat back was adjusted at the upright position and the seat track was adjusted full rearward. The tilt steering wheel was adjusted between the center and full down position. He was wearing a belt with various items of police equipment on it.

The driver observed the other vehicle turning left across his path and braked with full lock-up. As a result of the braking, the driver moved forward immediately prior to the impact. When the case vehicle impacted the other vehicle, the driver moved further forward, upward and slightly leftward, toward the 340 degree direction of force. Because he had already moved forward in response to the braking deceleration, the driver air bag deployed against his face and chest causing an abrasion on his forehead and bruising around his left eye. He lost his grip on the steering wheel and his hands flailed forward, striking the windshield and fracturing it, and causing lacerations on the knuckles of his right hand. His left arm encountered the air bag, causing bruising in the area above and below his left elbow. His own weight prevented the air bag from expanding outward and the combination of the air bag and his inertial force caused the top of the steering wheel rim to bend forward. His right knee impacted the knee bolster immediately below the steering column, causing a fracture of his right patella (knee cap). He had been bearing down on the brake pedal and sustained extensive bruising on the bottom of his right foot. As the case vehicle rotated clockwise, he rebounded rearward and was forcefully thrown to the right. His right shoulder area probably impacted the inboard edge of the driver's bucket seat back and he sustained a fracture of his right scapula, and he sustained bruising in the small of his back, probably from the equipment on his police belt. The side slap impact caused him to move to the left, and he remained in the seat as the vehicle slid to final rest.

CASE VEHICLE DRIVER'S INJURIES

The driver was transported to a local hospital via ambulance. We was hospitalized for two days for treatment and observation.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with prior unconsciousness of unknown length of time and amnesia	160410.2 moderate	Driver's air bag	Probable	Emergency room records
2	Fracture, comminuted, right patella with distraction	852400.2 moderate	Knee bolster, driver's, right of steering column	Certain	Hospitalization records
3	Fracture right scapula, inferior angle, with displacement	753000.2 moderate	Seat, back support	Possible	Hospitalization records

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
4	Abrasions forehead (i.e., above both right and left eyes) and next to left eye	290202.1 minor	Driver's air bag	Certain	Hospitalization records
5	Contusion left supraorbital area, not further specified	290402.1 minor	Driver's air bag	Certain	Hospitalization records
6	Abrasions, multiple, right hand, not further specified	790202.1 minor	Windshield	Certain	Hospitalization records
7	Laceration right 3rd digit, not further specified	790600.1 minor	Windshield	Certain	Hospitalization records
8	Contusion, left elbow area	790402.1 minor	Driver's air bag	Probable	Interviewee
9	Contusion, bottom of right foot	890402.1 minor	Foot controls	Probable	Interviewee
10	Contusion, "small" of the back	690402.1 minor	Police equipment in belt	Probable	Interviewee

OTHER VEHICLE

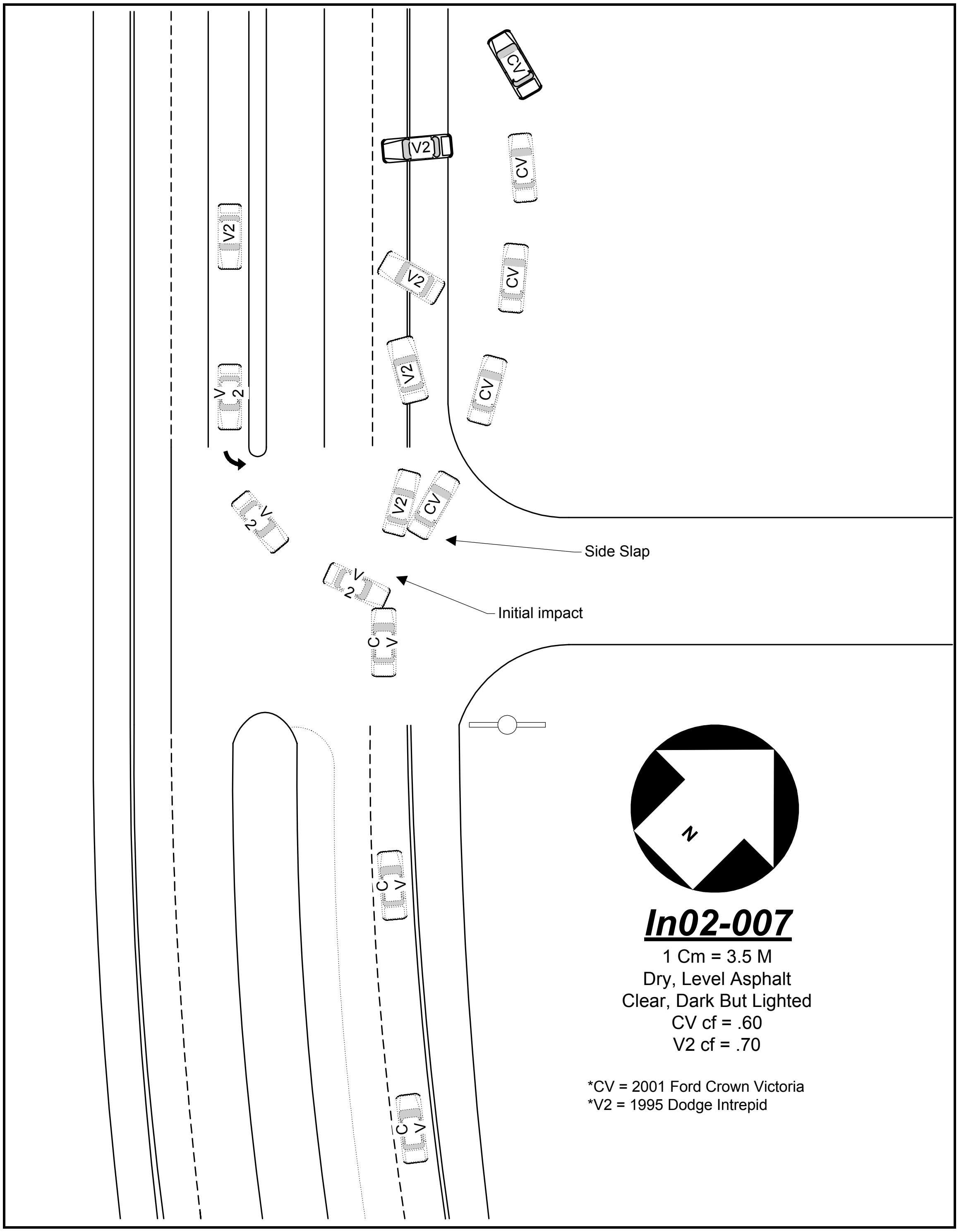
The other vehicle was a front wheel drive 1995 Dodge Intrepid four-door, five passenger sedan (VIN: 1B3HD56FX3F------), equipped with a 3.5 liter V-6 gasoline engine and an automatic transmission with a column-mounted selector lever. Four wheel anti-lock brakes were an option for this model, but it is not known if this vehicle was so equipped. The odometer reading is not known. Its wheelbase was 287 centimeters [113.0 inches]. The Dodge was towed due to disabling damage.

The Dodge sustained initial direct contact at the right front corner area that was measured as 91 centimeters [35.8 inches]. As the two vehicles rotated into each other, the entire right front fender sustained crushing and abrading (**Figure 8**). Maximum crush was measured as 61 centimeters [24.0 inches] at the right front corner. The CDC for the first impact was determined to be **02-RYEW-4 (80)**. The WinSMASH reconstruction program was used on the Dodge's most severe impact, based on the measured crush profile of both vehicles. The Total, Longitudinal and Lateral Delta-V's are for the Dodge's first impact are, respectively: 32.0 km.p.h. [19.9 m.p.h.], -10.9 km.p.h. [-6.8 m.p.h.] and -30.1 km.p.h. [-18.7 m.p.h.]. These results appear to be low.

Figure 8: Dodge Intrepid's right front damage from first (most severe) impact (case photo #73)

The Dodge also sustained direct contact on its right rear quarter panel from the side slap impact (event #2) with the case vehicle. Because of its high speed and configuration at the first impact, the case vehicle's rear wheels were probably raised up off the ground as the two vehicles pivoted into each other. As a result of the case vehicle being elevated, direct damage on the Dodge was restricted to the upper portion of the quarter panel and trunk lid (**Figure 9**). The CDC for the side slap impact was determined to be **03-RBMW-3 (90)**. The WinSMASH reconstruction for the Dodge's second impact indicated Total, Longitudinal and Lateral Delta-V's, respectively: 10.0 km.p.h. [6.2 m.p.h.], 0 km.p.h. [0 m.p.h.] and -10 km.p.h. [-6.2 m.p.h.]. These results appear to be reasonable.

Figure 9: Dodge Intrepid's right rear damage from side slap impact; note, no contact at bumper level (case photo #69)



V2
CV
Side Slap
Initial impact
N
In02-007
1 Cm = 3.5 M
Dry, Level Asphalt
Clear, Dark But Lighted
CV cf = .60
V2 cf = .70
*CV = 2001 Ford Crown Victoria
*V2 = 1995 Dodge Intrepid

APPENDIX A:

EVENT DATA RECORDER
(8 PAGES)

CDR File Information

Vehicle Identification Number	2FAFP71W81X------
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	2FAFP71W81X------.CDR
Saved on	11/6/02 2:43:00 PM
Data check information	82628F9
Collected with CDR version	Crash Data Retrieval Tool 1.385
Collecting program verification number	CA4043CE
Reported with CDR version	Crash Data Retrieval Tool 2.00
Reporting program verification number	3FF70DB6
Interface information	Block number: 00 Interface version: 2B Date: 01-18-02 Checksum: 6600
Event(s) recovered	Pretensioner 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 November 6, 2002, at 2:43 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.

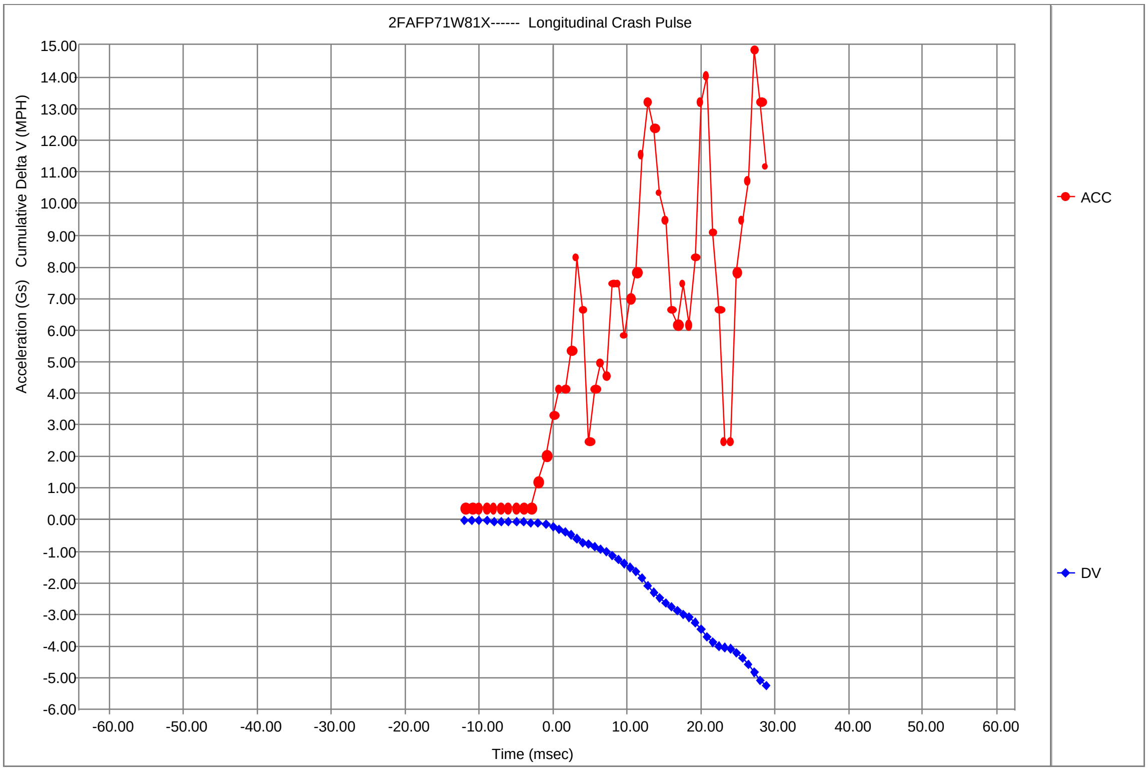
6. This module is not intended to record acceleration/deceleration in a side-impact event. If the side impact generates a longitudinal deceleration component sufficient to wake up the frontal deployment algorithm, there may be a recording of longitudinal deceleration in a side impact event.

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

Parameter	Driver	Passenger
Pretensioner Time (milliseconds)	NONE	NONE
First Stage Time (milliseconds)	11.2	11.2
Second Stage Time (milliseconds)	111.2	111.2


2FAFP71W81X------ Longitudinal Crash Pulse
Acceleration (Gs) Cumulative Delta V (MPH)
15.00
14.00
13.00
12.00
11.00
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
-1.00
-2.00
-3.00
-4.00
-5.00
-6.00
-60.00
-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

Longitudinal Crash Pulse Data

Milliseconds	Acceleration (Gs)	Cumulative Delta V (MPH)
-64	No Data	No Data
-63	No Data	No Data
-62	No Data	No Data
-61	No Data	No Data
-60	No Data	No Data
-59	No Data	No Data
-58	No Data	No Data
-57	No Data	No Data
-56	No Data	No Data
-55	No Data	No Data
-54	No Data	No Data
-53	No Data	No Data
-52	No Data	No Data
-51	No Data	No Data
-50	No Data	No Data
-49	No Data	No Data
-48	No Data	No Data
-47	No Data	No Data
-46	No Data	No Data
-45	No Data	No Data
-44	No Data	No Data
-43	No Data	No Data
-42	No Data	No Data
-41	No Data	No Data
-40	No Data	No Data
-39	No Data	No Data
-38	No Data	No Data
-37	No Data	No Data
-36	No Data	No Data
-35	No Data	No Data
-34	No Data	No Data
-33	No Data	No Data
-32	No Data	No Data
-31	No Data	No Data
-30	No Data	No Data
-29	No Data	No Data
-28	No Data	No Data
-27	No Data	No Data
-26	No Data	No Data
-25	No Data	No Data
-24	No Data	No Data
-23	No Data	No Data
-22	No Data	No Data
-21	No Data	No Data
-20	No Data	No Data
-19	No Data	No Data
-18	No Data	No Data
-17	No Data	No Data
-16	No Data	No Data
-15	No Data	No Data
-14	No Data	No Data

Milliseconds	Acceleration (Gs)	Cumulative Delta V (MPH)
-13	No Data	No Data
-12	0.41	-0.01
-11	0.41	-0.02
-10	0.41	-0.03
-9	0.41	-0.04
-8	0.41	-0.05
-7	0.41	-0.05
-6	0.41	-0.06
-5	0.41	-0.07
-4	0.41	-0.08
-3	0.41	-0.09
-2	1.24	-0.12
-1	2.06	-0.16
0	3.3	-0.24
0.8	4.13	-0.31
1.6	4.13	-0.38
2.4	5.37	-0.47
3.2	8.26	-0.62
4	6.61	-0.74
4.8	2.48	-0.78
5.6	4.13	-0.85
6.4	4.95	-0.94
7.2	4.54	-1.02
8	7.43	-1.15
8.8	7.43	-1.28
9.6	5.78	-1.38
10.4	7.02	-1.5
11.2	7.85	-1.64
12	11.56	-1.84
12.8	13.21	-2.08
13.6	12.39	-2.29
14.4	10.32	-2.47
15.2	9.5	-2.64
16	6.61	-2.76
16.8	6.19	-2.87
17.6	7.43	-3
18.4	6.19	-3.11
19.2	8.26	-3.25
20	13.21	-3.48
20.8	14.04	-3.73
21.6	9.08	-3.89
22.4	6.61	-4
23.2	2.48	-4.05
24	2.48	-4.09
24.8	7.85	-4.23
25.6	9.5	-4.39
26.4	10.74	-4.58
27.2	14.86	-4.84
28	13.21	-5.08
28.8	11.15	-5.27
29.6	No Data	No Data
30.4	No Data	No Data
31.2	No Data	No Data
32	No Data	No Data

Milliseconds	Acceleration (Gs)	Cumulative Delta V (MPH)
32.8	No Data	No Data
33.6	No Data	No Data
34.4	No Data	No Data
35.2	No Data	No Data
36	No Data	No Data
36.8	No Data	No Data
37.6	No Data	No Data
38.4	No Data	No Data
39.2	No Data	No Data
40	No Data	No Data
40.8	No Data	No Data
41.6	No Data	No Data
42.4	No Data	No Data
43.2	No Data	No Data
44	No Data	No Data
44.8	No Data	No Data
45.6	No Data	No Data
46.4	No Data	No Data
47.2	No Data	No Data
48	No Data	No Data
48.8	No Data	No Data
49.6	No Data	No Data
50.4	No Data	No Data
51.2	No Data	No Data
52	No Data	No Data
52.8	No Data	No Data
53.6	No Data	No Data
54.4	No Data	No Data
55.2	No Data	No Data
56	No Data	No Data
56.8	No Data	No Data
57.6	No Data	No Data
58.4	No Data	No Data
59.2	No Data	No Data
60	No Data	No Data
60.8	No Data	No Data
61.6	No Data	No Data

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:  16 BB F2 00 0B 00 00 32 0E 22 0E 2B 38 55 18 06
0010:  00 7D 0C 19 0C 19 05 CC 31 57 37 41 02 03 71 7D
0020:  61 00 35 31 35 31 38 46 33 41 00 00 00 00 00 00
0030:  00 00 00 00 00 00 00 00 00 00 32 31 35 32 39 36
0040:  31 38 00 00 00 00 00 00 00 00 1D D2 02 80 14 D8
0050:  01 80 17 00 01 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 09 04 00 00 00 00 00 00 00 00 33 01
0080:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
0090:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00A0:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00B0:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00C0:  00 00 00 00 00 00 00 00 00 00 00 00 00 00 00 00
00D0:  00 00 00 00 00 00 00 00 00 00 00 00 00 82 82 82
00E0:  82 82 82 82 82 82 82 84 86 89 8B 8B 8E 95 91 87
00F0:  8B 8D 8C 93 93 8F 92 94 9D A1 9F 9A 98 91 90 93
0100:  90 95 A1 A3 97 91 87 87 94 98 9B A5 A1 9C 00 0E
0110:  00 8B 00 0E 00 8B 00 00 00 00 00 0E 19 1B 19 1B
0120:  00 00 00 08 00 09 00 09 00 4D 00 4D 29 28 81 39
0130:  00 33 AF 03 02 6C 0A 0C 02 02 0E 85 07 43 09 AE
0140:  01 00 00 00 05 05 03 04 05 05 03 FE 00 24 00 5E
0150:  00 61 00 DF 00 A9 00 00 00 C2 09 AE 01 5C 00 F9
0160:  00 ED 00 FE 01 2A 01 1B 00 80 01 8F 00 C6 01 8F
0170:  00 8C 01 2A 01 1B 00 D0 00 E3 02 B2 01 F0 01 6D
0180:  01 99 00 F9 00 94 00 BF 00 C6 00 A9 00 ED 00 85
0190:  FF FE FF FE 00 6D FF FE 00 72 00 B3 00 BD 00 00
01A0:  00 BD 07 02 0A 02 02 6C 04 D7 13 5C 09 AE 00 00
01B0:  00 01 03 0A 03 06 04 04 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:  00 79 00 B6 00 DF 00 96 00 C4 00 C6 29 00 8A A5
```