On Site Advanced Occupant Protection Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS03014
2001 Ford Crown Victoria
Arizona
March, 2003

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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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16. Abstract

This Advanced Occupant Protection crash occurred in March, 2003 at 2030 hours. This two-vehicle crash took place within the confines of a four leg intersection. The speed limit is 89 km/h (55 mph). All roadways were of asphalt construction and were dry. It was dark at the time of the crash and the street lights were on. The case vehicle was a 2001 Ford Crown Victoria Police Interceptor driven by a properly restrained 29-year-old male. The other vehicle was a 1992 Freightliner conventional cab behind engine tractor driven by a 31-year-old male that was pulling a 16 m (53 ft) Merritt livestock trailer.

The case vehicle was traveling northbound and was in the left hand turn lane. The other vehicle was traveling eastbound. The case vehicle attempted a left hand turn (to go west) in front of the other vehicle. The driver of the other vehicle braked and steered left. The front of the case vehicle struck the front of the other vehicle. Both front air bags deployed in the case vehicle. The case vehicle rotated clockwise and came to rest in the intersection. The other vehicle veered to the left, departed the roadside, and came to rest against an embankment.

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, AOPS, advanced, police vehicle	

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Dynamic Science, Inc.
Crash Investigation
Case Number: DS03014

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BACKGROUND:

Description:	This Advanced Occupant Protection (AOPS) case was identified by the local National Automobile Sampling System team. DSI was assigned the case on April 30, 2003. This was an on-scene investigation. All field work was completed on May 5, 2003.
Investigation Type:	Advanced Occupant Protection
Crash Location:	Arizona
Crash Date:	March, 2003
Notification Date:	April 30, 2003
Field Work Completed:	May 5, 2003

SUMMARY

Crash Site

This two vehicle crash occurred in March, 2003 at 2030 hours. The crash took place within the confines of a four leg intersection. The northbound leg of the intersection was comprised of one through/right hand turn lane, one left turn lane, and one southbound lane. A stop sign in present. The speed limit is 89 km/h (55 mph). The eastbound leg of the intersection was comprised of a right hand turn lane, an eastbound through lane, a left hand turn lane, and two westbound through lanes. The road has a slight left hand curve. There is +2.1% grade. The speed limit is 89 km/h (55 mph). All roadways were of asphalt construction and were dry. It was dark at the time of the crash and the street lights were on.

Figure 1. Case vehicle approach (north)

Pre-Crash

The case vehicle was a 2001 Ford Crown Victoria Police Interceptor driven by a properly restrained 29-year-old male (180 cm/71 in, 108 kg/240 lbs). The driver was wearing his protective vest. The other vehicle was a 1992 Freightliner conventional cab behind engine (CBE) tractor that was being driven by a 31-year-old male. This vehicle was pulling a 16 m (53 ft) Merritt livestock trailer that was fully loaded with cattle.

Figure 2. Other vehicle approach (east)

The case vehicle was traveling northbound and was in the left hand turn lane. The other vehicle was traveling eastbound. The case vehicle attempted a left hand turn (to go west) in front of the other vehicle. The driver of the other vehicle braked and steered left.

Crash

The front of the case vehicle (11FDEW2) struck the front of the other vehicle. The case vehicle sustained a total delta V of 42.0 km/h (26.1 mph)[1] as calculated using the barrier option of the WinSmash collision model. The longitudinal and lateral delta V components were -36.4 km/h (-22.6 mph) and 21.0 km/h (13.0 mph), respectively. This was a borderline reconstruction because the crash is beyond the scope of WinSmash. Both front air bags deployed in the case vehicle. The case vehicle rotated clockwise and came to rest in the intersection. The other vehicle veered to the left and departed the roadway on the left side. The front left tire struck a metal pole–causing minor contact damage. The vehicle continued on and struck an embankment with its front end before coming to rest.

Figure 3. Front right, case vehicle

Figure 4. Right side, side view of crush

Post-Crash

The driver of the case vehicle sustained a mild left chest contusion, thoracic and lumbar strains, and an abrasive type injury to the left hand. He refused treatment at the scene but did seek medical treatment three hours after the crash. He arrived at the hospital with a Glasgow Coma Scale (GCS) of 15. He was treated and released at 0219 hours the following morning. The driver of the other vehicle did not report any injuries. He refused treatment at the scene. He was transported to a local hospital where he was examined and released with no injuries.

Both vehicles were towed from the scene due to damage.

[1]Calculated using stiffness values derived from NCAP test 3077.

SCENE DIAGRAM

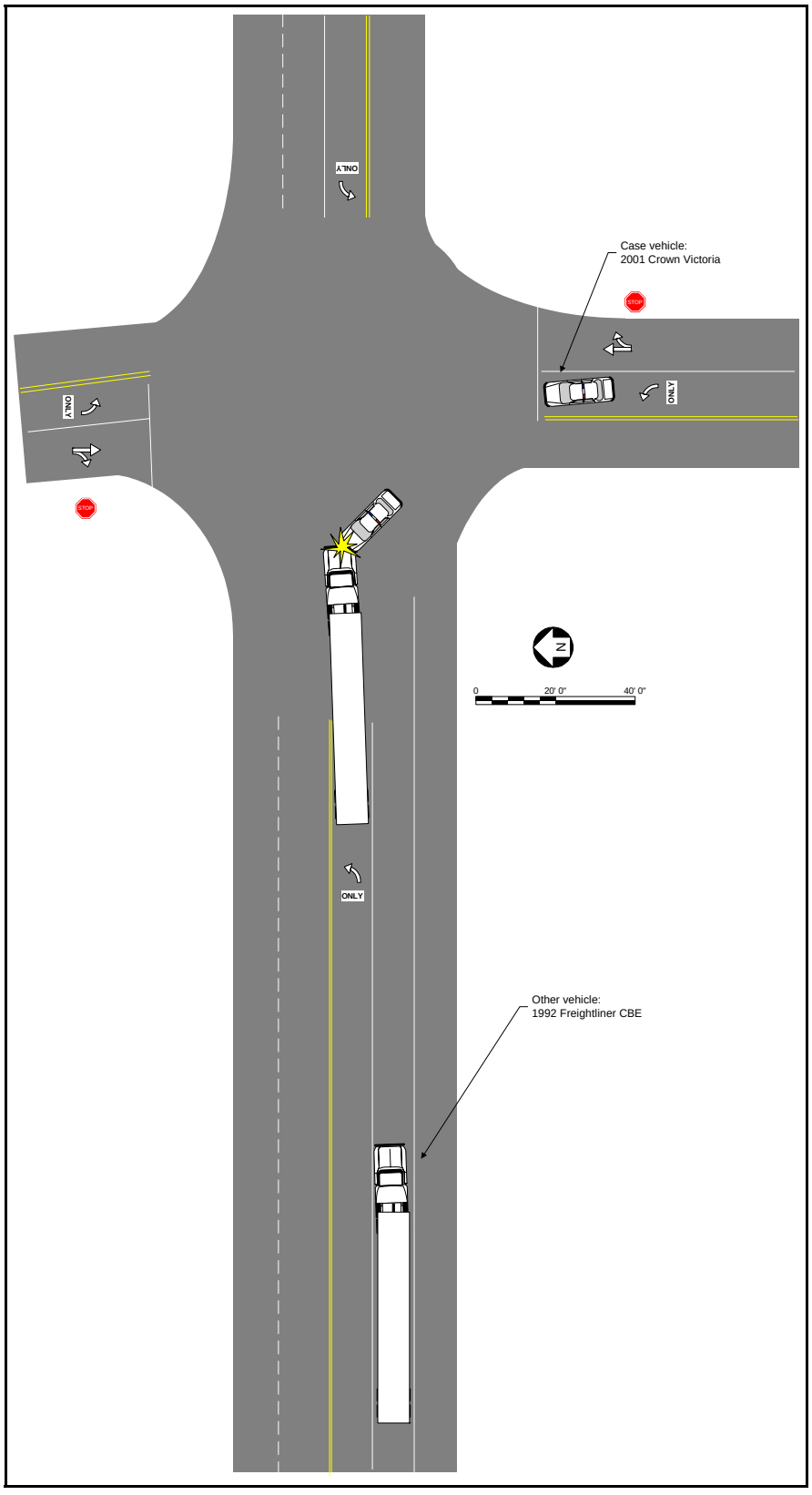


Figure 5. Scene diagram (impact)

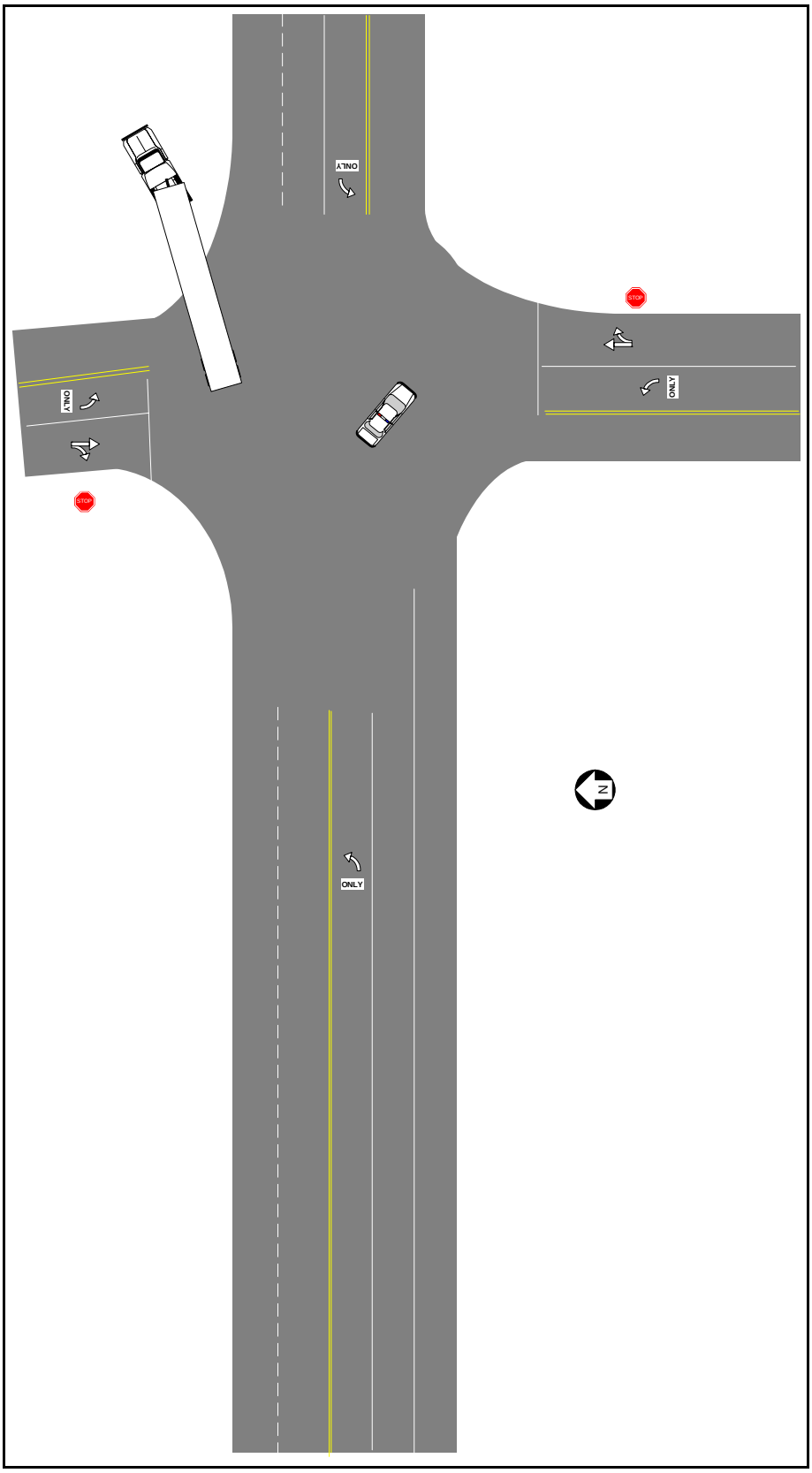


Figure 6. Scene diagram (final rest)

VEHICLE DATA - 2001 Ford Crown Victoria Police Interceptor

The 2001 Ford Crown Victoria Police Interceptor was a four-door sedan modified for law enforcement activities. The vehicle was equipped with a rear wheel drive, 4-speed automatic transmission, heavy duty suspension, increased cooling, heavy duty frame, and 4-wheel disc brakes.

VIN:	2FAFP71WX1xxxxxx
Odometer:	Unknown
Engine:	4.6 L, V8
Reported Defects:	None related
Cargo:	Police package, computer CPU, radios, weapons.

The 2001 Ford Crown Victoria was equipped with Goodyear Eagle RS-A P225/60R16 tires. The specific tire data is as follows:

Tire	Tread	Measured pressure	Manufacturer recommended pressure
LF	5.5 mm (0.22 in)	241 kPa (35 psi)	241 kPa (35 psi)
LR	5.5 mm (0.22 in)	241 kPa (35 psi)	241 kPa (35 psi)
RF	5.5 mm (0.22 in)	234 kPa (34 psi)	241 kPa (35 psi)
RR	5.5 mm (0.22 in)	248 kPa (36 psi)	241 kPa (35 psi)

The front seating positions in the 2001 Ford Crown Victoria were configured with fabric covered bucket seats with adjustable head restraints. The rear seat is a one-piece plastic seat designed for prisoner transport. The front seats were separated from the rear seats by a metal and plexiglass floor to roof partition.

VEHICLE DAMAGE

Exterior Damage - 2001 Ford Crown Victoria

Damage Description:	Moderate front end. Damage to bumper, backing bar, grille, hood.	
CDC:	11FDEW2	
Delta V[2]:	Total	42.0 km/h (26.1 mph)
	Longitudinal	-36.4 km/h (-22.6 mph)
	Latitudinal	21.0 km/h (13.0 mph)
	Energy	177,301 joules (130,770 ft lbs)

The Crown Victoria sustained moderate damage to the entire front end. The direct damage started at the front right bumper corner and extended laterally for 131.0 cm (51.5 in). The Crown Victoria underrode the Freightliner which allowed the hood and grille area to sustain direct contact damage. There was damage to the radiator and upper and lower radiator supports. The right front door was jammed shut. Both front fenders sustained inducted buckling. Six crush measurements were taken along the bumper face and were as follows: C1=2.0 cm (0.8 in), C2=25.0 cm (9.8 in), C3=61.0 cm (24.0 in), C4=42.0 cm (16.5 in), C5=51.0 cm (20.0 in), C6=15.0 cm (5.9 in).

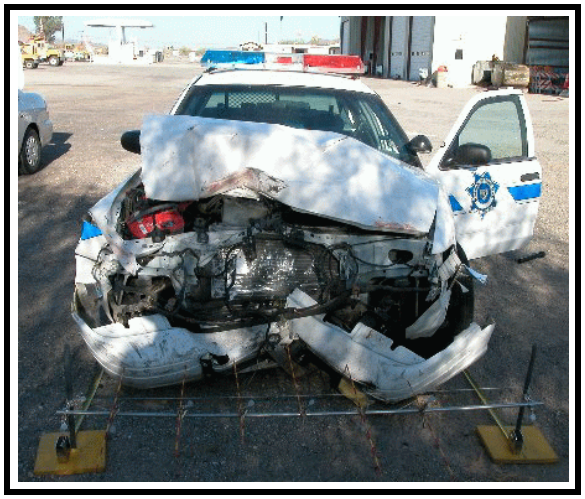


Figure 7. Front, case vehicle

[2]Borderline reconstruction. Crash was beyond the scope of WinSmash and the barrier option was used.

Interior Damage - 2001 Ford Crown Victoria

There was no damage to the interior beyond that associated with the air bag deployments. There was no steering wheel deformation or steering column compression. Prior to the vehicle inspection work had been done to remove a radio.

MANUAL RESTRAINT SYSTEMS - 2001 Ford Crown Victoria

The Crown Victoria was configured with manual 3-point lap and shoulder belts with sliding latch plates for both front seat positions. The front seat restraints were configured with adjustable shoulder belt anchorages. Both anchorages were adjusted to the full down position. Both front seat belts were equipped with pretensioners. The retractors were located in the lower B pillars. The driver's seat belt pretensioner did actuate during the crash.

Figure 8. Driver's seat belt

The outboard rear seat positions were equipped with lap and shoulder belts with locking latch plates. There are separate buckles for both lap and shoulder portions of the belts. The buckle for the shoulder harness is located at the upper outboard edges of the outboards seats. The buckle for the lap belt is located at the lower outboard edges of the outboard seats.

Figure 9. Rear seat lap and shoulder belts

FRONTAL AIR BAG SYSTEM - 2001 Ford Crown Victoria

This vehicle was equipped with an advanced occupant protection system. The system consists of a Restraint Control Module (RCM), dual stage front air bags, seat belt pretensioners, seat track sensors, and seat belt buckle engagement detectors. The system is controlled by the RCM. The primary function of the RCM is to control the deployment of the occupant protection systems. Data related to the driver and passenger air bag deployment include: 120 milliseconds of crash pulse, deployment strategy of the dual-stage air bag system, seat belt buckle engagement, pretensioner operation, and driver seat track location.

Figure 10. Driver's air bag

The downloaded data indicates a cumulative longitudinal delta V of 8.5 km/h (-5.3 mph) at the 56.8 ms mark. The results are low and incomplete. It appears that the power was interrupted to the RCM during the recording of data and a partial recording occurred. This is shown as "no data" in the data table and is not plotted on the graph of acceleration. When some portion of the acceleration data is not recorded, the delta V during that time is not calculated. A delta V is calculated for the points that are valid but the partial delta V calculated will underestimate the actual event total delta V. Vetronix indicates that the restraint device deployment times are recorded first into memory, and the acceleration data is recorded last. Thus, even with partial acceleration traces, deployment times are valid.

Figure 11. Front right passenger air bag

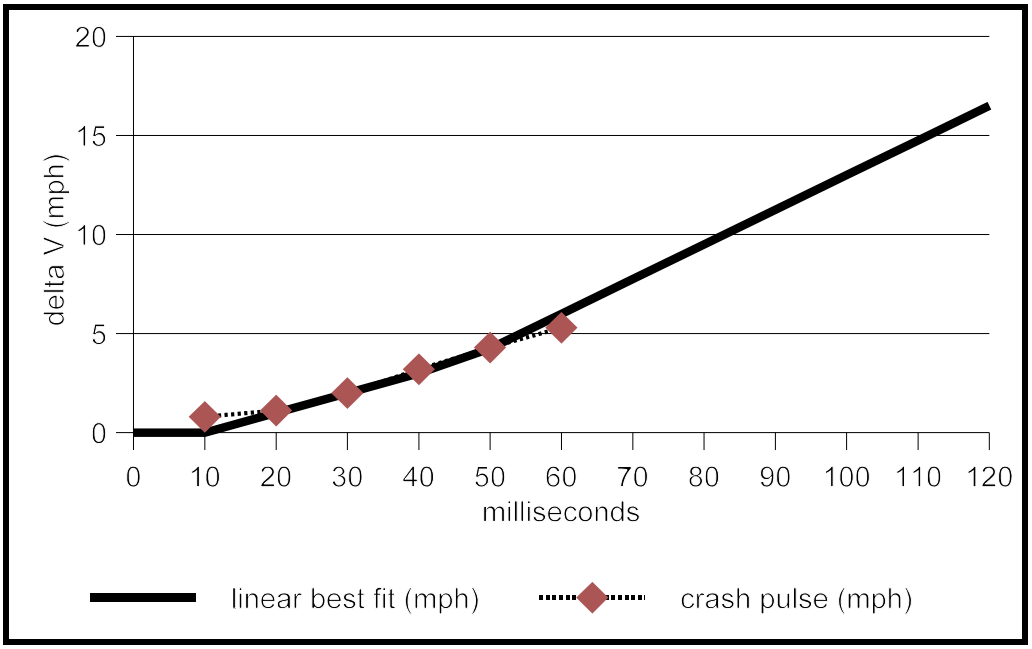


Figure 12. Linear best fit projection

A linear best fit projection indicated a trend that would have put the delta v at 26.5 km/h (16.5 mph) at the 120 ms mark. This projection is essentially an approximation that indicates that the delta V had an upward trend when the recording stopped.

The Vetronix report further indicated that:

1. This was a first stage deployment.
2. The driver's seat was not in the forward position.
3. The left front buckle was buckled, the right was not.
4. The time from algorithm wake-up to driver pretensioner fire was 40 milliseconds.
5. The time from algorithm wake-up to driver first stage deployment was 44.8 milliseconds.

There is some conflicting information regarding the status of the passenger pretensioner and the second stage deployment times. Both front seat positions of the case vehicle were equipped with seat belt pretensioners. The retractors are located in the lower B pillars. It appears that the driver's seat belt pretensioner fired and the passenger's did not, which is consistent with no passenger seated in the front right seat. The system status indicator in the Vetronix report indicated a "fire" for the passenger pretensioner. There are times given for second stage deployment, but the system status indicates "no fire" for both sides.

Figure 13. Driver's seat belt latch

The case vehicle was equipped with a driver's air bag and a front right passenger's air bag. The driver's steering wheel mounted air bag was circular and measured 50.0 cm (19.7 in) in diameter. It was equipped with two tethers and two vent ports. The vent ports were at the 11 and 1 o'clock positions. The single module cover opened in a "U" configuration. There were no indications of damage or contact to either the air bag or the module cover. The front right passenger's mid mounted air bag was rectangular and measured 42.0 cm (16.5 in) wide from seam to seam and 56.0 cm (22.0 in) high. There was a single vent port on the left side. The single flap module cover opened vertically. On the face of the air bag was cover-related scuffing. The module cover did not sustain any damage or contact.

VEHICLE DATA -1992 Freightliner semi

Description:	1992 Freightliner 6x4 conventional cab truck tractor with 16 m (53 ft) Merritt livestock trailer	
VIN:	1FUYDSEB3NPxxxxxx	
Odometer:	Unknown	
Engine:	12.7 L, 8 cylinder	
Reported Defects:	None	
Cargo:	Unknown weight, fully loaded with cattle	
Damage Description:	Towed, due to damage. Police indicate vehicle disabled. Right front axle wheel and left springs torn off frame. Left front wheel slid back onto leaf springs. Passenger side fuel tank torn off vehicle.	
TDC:	Unknown	
Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

Figure 14. Exemplar view of Merritt livestock trailer

OCCUPANT DEMOGRAPHICS - 2001 Ford Crown Victoria

	Driver
Age/Sex:	29/Male
Seated Position:	Front left
Seat Type:	Fabric covered bucket seat. Seat adjusted to rear most track position. Seat back slightly reclined.
Height:	180 cm (71 in)
Weight:	109 kg (240 lbs)
Occupation:	Police officer
Pre-existing Medical Condition:	Arthroscopy left knee, G6PD[3] deficiency
Alcohol/Drug Involvement:	None
Driving Experience:	13 years
Body Posture:	Normal, upright
Hand Position:	Both hands on steering wheel. Right above left.
Foot Position:	Right foot on accelerator, left on floorboard
Restraint Usage:	Lap and shoulder belt available, used
Air bag:	Steering wheel mounted air bag available, deployed

[3]G-6-PD deficiency is a hereditary enzyme defect that results in the breakdown of red blood cells when the person is exposed to the stress of infection or certain drugs.

OCCUPANT DEMOGRAPHICS - other vehicle

Age/Sex:	31/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Truck driver
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be greater than 10 years
Body Posture:	Normal, upright
Hand Position:	Unknown
Foot Position:	Right foot on brake, left on floorboard
Restraint Usage:	Lap and shoulder belt used, per police report

OCCUPANT INJURIES -2001 Ford Crown Victoria

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Chest contusion, left side	490402.1,2	922.1	Shoulder belt
	Thoracic spine strain	640478.1,7	847.1	Impact forces
	Lumbar spine strain	640678.1,8	847.2	Impact forces
	Abrasion, left hand	790202.1,2	913.0	Door side panel. Fling injury. Air bag related.

OCCUPANT INJURIES - other vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Not injured			

OCCUPANT KINEMATICS - 2001 Ford Crown Victoria

Figure 15. Driver's seated area

The 29-year-old male driver of the case vehicle was seated in a normal, upright fashion on the fabric covered bucket seat. The seat had been adjusted to the rear most track position. The seat back was slightly reclined. The driver was wearing the available 3-point lap and shoulder belt. The manual shoulder belt upper anchorage was in the full down position. The front seat belts were equipped with B-pillar mounted pretensioners and emergency locking retractors. The driver was wearing his protective vest. The driver was involved in a turning maneuver. His left hand was below his right. His right foot was on the accelerator, his left was on the floor. At impact, the front air bags deployed and the outboard seat belt pretensioners actuated. The driver responded to the 11 o'clock direction of force by exhibiting a slightly left of forward trajectory and loading the pretensioned and locked manual restraint system–causing a contusion on the left side of his chest and the lumbar and thoracic strains. The driver's face likely contacted the deployed air bag, but there were no indications of any contact to the air bag. The driver did sustain a burn/abrasion to the top of his left hand that was likely caused by the deploying driver's air bag flinging his hand into the door side panel. He was able to exit the vehicle on his own. He refused treatment at the scene but did seek medical treatment three hours after the crash.

Attachment 1. Vetronix report

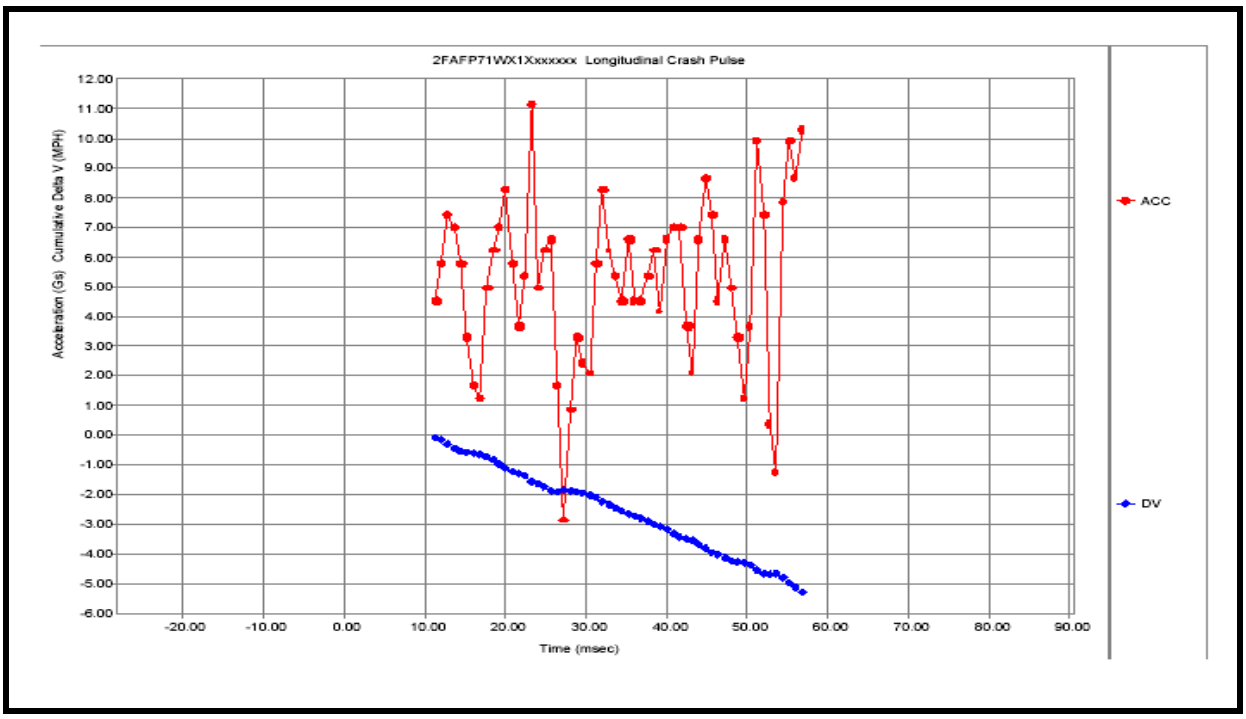
CDR File Information

Vehicle Identification Number	2FAFP71WX1Xxxxxxx
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	DS03014.CDR
Saved on	05/05/2003 8:00:45 AM
Data check information	F578E0C0
Collected with CDR version	Crash Data Retrieval Tool 2.00
Collecting program verification number	A31D1C76
Reported with CDR version	Crash Data Retrieval Tool 2.00
Reporting program verification number	A31D1C76
Event(s) recovered	Pretensioner Deployment

Parameter	Driver	Passenger
Pretensioner Time (milliseconds)	40	NONE
First Stage Time (milliseconds)	44.8	40
Second Stage Time (milliseconds)	144.8	140

System Status At Deployment

Ford Part Number Prefix	1W7A
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	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


2FAFP71WX1Xxxxxxx Longitudinal Crash Pulse
Acceleration (Gs) Cumulative Delta V (MPH)
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
-20.00
-10.00
0.00
10.00
20.00
30.00
40.00
50.00
60.00
70.00
80.00
90.00
Time (msec)
ACC
DV

Crash Pulse Data

Milliseconds	Long. Acceleration (Gs)	Long. Cumulative Delta V (MPH)
-28.0	No Data	No Data
-27.0	No Data	No Data
-26.0	No Data	No Data
-25.0	No Data	No Data
-24.0	No Data	No Data
-23.0	No Data	No Data
-22.0	No Data	No Data
-21.0	No Data	No Data
-20.0	No Data	No Data
-19.0	No Data	No Data
-18.0	No Data	No Data
-17.0	No Data	No Data
-16.0	No Data	No Data
-15.0	No Data	No Data
-14.0	No Data	No Data
-13.0	No Data	No Data
-12.0	No Data	No Data
-11.0	No Data	No Data
-10.0	No Data	No Data
-9.0	No Data	No Data
-8.0	No Data	No Data
-7.0	No Data	No Data
-6.0	No Data	No Data
-5.0	No Data	No Data
-4.0	No Data	No Data
-3.0	No Data	No Data
-2.0	No Data	No Data
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0.0	No Data	No Data
0.8	No Data	No Data
1.6	No Data	No Data
2.4	No Data	No Data
3.2	No Data	No Data
4.0	No Data	No Data
4.8	No Data	No Data
5.6	No Data	No Data
6.4	No Data	No Data
7.2	No Data	No Data
8.0	No Data	No Data
8.8	No Data	No Data
9.6	No Data	No Data
10.4	No Data	No Data
11.2	4.54	-0.08
12.0	5.78	-0.18
12.8	7.43	-0.31
13.6	7.02	-0.43
14.4	5.78	-0.54
15.2	3.30	-0.59
16.0	1.65	-0.62
16.8	1.24	-0.64
17.6	4.95	-0.73
18.4	6.19	-0.84
19.2	7.02	-0.96
20.0	8.26	-1.11
20.8	5.78	-1.21
21.6	3.72	-1.28
22.4	5.37	-1.37
23.2	11.15	-1.57
24.0	4.95	-1.65
24.8	6.19	-1.76
25.6	6.61	-1.88
26.4	1.65	-1.91
27.2	-2.89	-1.86
28.0	0.83	-1.87
28.8	3.30	-1.93
29.6	2.48	-1.97
30.4	2.06	-2.01
31.2	5.78	-2.11
32.0	8.26	-2.25
32.8	6.19	-2.36
33.6	5.37	-2.46
34.4	4.54	-2.54
35.2	6.61	-2.65
36.0	4.54	-2.73
36.8	4.54	-2.81
37.6	5.37	-2.91
38.4	6.19	-3.01
39.2	4.13	-3.09
40.0	6.61	-3.20
40.8	7.02	-3.33
41.6	7.02	-3.45
42.4	3.72	-3.51
43.2	2.06	-3.55
44.0	6.61	-3.67
44.8	8.67	-3.82
45.6	7.43	-3.95
46.4	4.54	-4.03
47.2	6.61	-4.14
48.0	4.95	-4.23
48.8	3.30	-4.29
49.6	1.24	-4.31
50.4	3.72	-4.38
51.2	9.91	-4.55
52.0	7.43	-4.68
52.8	0.41	-4.69
53.6	-1.24	-4.67
54.4	7.85	-4.80
55.2	9.91	-4.98
56.0	8.67	-5.13
56.8	10.32	-5.31
57.6	No Data	No Data
58.4	No Data	No Data
59.2	No Data	No Data
60.0	No Data	No Data
60.8	No Data	No Data
61.6	No Data	No Data
62.4	No Data	No Data
63.2	No Data	No Data
64.0	No Data	No Data
64.8	No Data	No Data
65.6	No Data	No Data
66.4	No Data	No Data
67.2	No Data	No Data
68.0	No Data	No Data
68.8	No Data	No Data
69.6	No Data	No Data
70.4	No Data	No Data
71.2	No Data	No Data
72.0	No Data	No Data
72.8	No Data	No Data
73.6	No Data	No Data
74.4	No Data	No Data
75.2	No Data	No Data
76.0	No Data	No Data
76.8	No Data	No Data
77.6	No Data	No Data
78.4	No Data	No Data
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84.0	No Data	No Data
84.8	No Data	No Data
85.6	No Data	No Data
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