Child Air Bag Related Fatality Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS04024
1997 Ford Crown Victoria
Arizona
December, 2004

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
DS04024		

4. Title and Subtitle	5. Report Date
Child Air Bag Related Fatality Investigation	April 28, 2005
	6. Performing Organization Report No.

7. Author(s)	8. Performing Organization Report No.
Dynamic Science, Inc.	

9. Performing Organization name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 530 College Parkway, Ste. K Annapolis, MD 21401	11. Contract or Grant no. DTNH22-94-D-27058

12. Sponsoring Agency Name and Address	13. Type of report and period Covered [Report Month, Year]
U.S. Dept. of Transportation (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

This on-site investigation focused on the air bag related injuries sustained by the front right seat occupant of a 1997 Ford Crown Victoria. The child occupant was seated in a forward facing high back booster child safety seat (CSS). The CSS was installed using the vehicle's manual 3-point lap and shoulder belt. The Crown Victoria was occupied by an unrestrained male driver and a 3-year-old male front right seat passenger, restrained in the forward facing CSS. This two vehicle crash occurred in December, 2004 at approximately 1345 hours in a rural area of Arizona. The crash occurred within the confines of a four-leg intersection. The Crown Victoria struck the right front of a 1997 Chevrolet Blazer in an intersection crash. Both front air bags in the Crown Victoria deployed. The driver of the Crown Victoria sustained abrasions to the left hand. The 3-year-old child engaged the deploying air bag. He was transported by helicopter to an area trauma center where he was declared dead shortly after arrival. The cause of death was listed as "craniocervical dislocation due to blunt impact to head."

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, crash, fatality, child safety seat, child passenger.	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

Dynamic Science, Inc.
Accident Investigation
Case Number: DS04024

TABLE OF CONTENTS

BACKGROUND:

Description:

This on-site investigation focused on the air bag related injuries sustained by the front right seat occupant of a 1997 Ford Crown Victoria. The child occupant was seated in a forward facing high back booster child safety seat (CSS). The CSS was installed using the vehicle's manual 3-point lap and shoulder belt. The Crown Victoria was occupied by an unrestrained male driver and a 3-year-old male front right seat passenger, restrained in the forward facing CSS. The Crown Victoria struck the right front of a 1997 Chevrolet Blazer in an intersection crash. Both front air bags in the Crown Victoria deployed. The driver of the Crown Victoria sustained abrasions to the left hand. The 3-year-old child engaged the deploying air bag. He was transported by helicopter to an area trauma center where he was declared dead shortly after arrival. The cause of death was listed as "craniocervical dislocation due to blunt impact to head."

Figure 1. Front left, Crown Victoria

This potential Passenger Air Bag Related Fatality case was identified by NHTSA from a news report. The crash occurred in December, 2004. DSI was notified on December 7, 2004. All field work was completed on December 10, 2004.

SUMMARY:

Crash Site

This two vehicle crash occurred in December, 2004 at approximately 1347 hours in a rural area of Arizona. The crash occurred within the confines of a four-leg intersection. The northbound leg of the intersection is comprised of two northbound travel lanes, a left turn lane, and two southbound travel lanes. The roadway is of asphalt construction. There are asphalt shoulders on both sides of the roadway. The speed limit is 89 km/h (55 mph). The southbound leg of the intersection is comprised of two southbound travel lanes, a left turn lane, and two northbound travel lanes. The roadway is of asphalt construction. There are asphalt shoulders on both sides

Figure 2. Approach to area of impact-south

of the roadway. The speed limit is 89 km/h (55 mph). Both roadways have irregular undulations as they approach the intersection. The intersection is controlled by tri-color traffic signals.

Pre Crash

The case vehicle is a 1997 Ford Crown Victoria four-door sedan (VIN: 2FALP71W8VXxxxxxx) driven by a 28-year-old male. The front right seat was occupied by a 3-year-old male. He was seated in a Cosco High Back Booster seat. He was wearing the five-point booster seat harness. The seat was anchored to the vehicle using the available lap and shoulder belt. The other vehicle is a 1997 Chevrolet Blazer (VIN: 1GNDT13W5V2xxxxxx) driven by a 43-year-old female.

Figure 3. 1997 Crown Victoria–view from news video

The Crown Victoria was traveling south in the second lane from the right approaching the intersection at police estimated speed of 66-72 km/h (41-45 mph). Prior to reaching the intersection, the driver of the Crown Victoria changed lanes to the right. The Chevrolet Blazer was initially traveling north and had entered the left hand turn lane. As the vehicles reached the intersection, the driver of the Chevrolet Blazer attempted to make a left hand turn. The police estimate the Blazer speed to be 23-27 km/h (14-17 mph).

Crash

The front of the Crown Victoria (11 FDEW2) struck the right side of the Blazer. The total velocity change for the Crown Victoria as calculated by the missing vehicle algorithm of the WinSmash program was 30.0 km/h (18.6 mph). The longitudinal and lateral delta V components were -28.2 km/h (-17.5 mph) and 10.3 km/h (6.4 mph), respectively. Both front air bags in the Crown Victoria deployed at this time. The Crown Victoria rotated clockwise and the Blazer rotated in a counterclockwise direction. There was a second impact between the left side of the Crown Victoria (09LYEW1) and the right side of the Blazer. The Crown Victoria came to rest in the intersection facing southwest. The Blazer came to rest facing south partially in the northbound left turn lane and partially in the southbound travel lane. The driver of the Blazer moved her vehicle from final rest to the west side of the roadway, leaving a fluid leak trail.

Post Crash

The driver of the Crown Victoria was able to exit the vehicle on his own. He sustained a sprained left wrist. The front right seat child occupant was removed from the vehicle by private citizens. He remained in the child seat while CPR was being performed. He remained in the seat until paramedics arrived.

The driver of the Crown Victoria was transported from the scene to a local trauma center by

ground ambulance. He was treated for abrasions to the left hand and then released. The front right seat child occupant was fatally injured. He was transported by helicopter to an area trauma center where he was declared dead shortly after arrival. The cause of death was listed as "craniocervical dislocation due to blunt impact to head." He sustained multiple injuries, including: a craniocervical dislocation, a cervical dislocation, brain contusions, contusions of the mouth and tongue, bilateral lung contusions, and multiple abrasions/contusions to the face and torso.

DETAILED INFORMATION

VEHICLE DATA - 1997 Ford Crown Victoria Police Interceptor

The 1997 Ford Crown Victoria four door sedan was identified by the Vehicle Identification Number (VIN): (VIN: 2FALP71W8VXxxxxxx). The Crown Victoria was equipped with a 4.6 liter engine, automatic transmission, rear wheel drive, and four-wheel disc brakes. The case vehicle was equipped for use by police agencies. It is designed with Ford's full-size "Panther" platform–a body on frame design undergirds the Ford Crown Victoria, Mercury Grand Marquis, and Lincoln Town Car.

The Crown was equipped with BF Goodrich Premier P215/70R15 tires. The specific tire data is as follows:

Tire	Tread	Measured Pressure	Manufacture's Recommended Pressure
LF	3 mm (4/32 in)	207 kPa (30 psi)	241 kPa (35 psi)
LR	3 mm (3/32 in)	228 kPa (33 psi)	241 kPa (35 psi)
RF	2 mm (4/32 in)	179 kPa (26 psi)	241 kPa (35 psi)
RR	2 mm (3/32 in)	207 kPa (30 psi)	241 kPa (35 psi)

VEHICLE DAMAGE

Exterior Damage - 1997 Ford Crown Victoria

The 1997 Ford Crown Victoria sustained moderate front end damage as result of the first impact with the Chevrolet Blazer. The bumper was pushed rearward and the hood was buckled. All the doors remained closed and operational. The right wheelbase was shortened by 14.0 cm (5.5 in). There was windshield damage from an occupant contact. The direct damage from the initial impact began 14.0 cm (5.5 in) from the front right bumper corner and extended laterally 134.0 cm (52.7 in) along the bumper. Six crush measurements were documented at the backing bar level as follows: 1.0 cm (0.4 in), 20.0 cm (7.9 in), 41.0 cm (16.1 in), 46.0 cm (18.1 in), 35.0 cm (13.8 in), 25.0 cm (9.8 in). The Crown Victoria sustained minor left side damage as a result of the second impact with the Chevrolet Blazer. The direct damage began 60.0 cm (23.6 in) rearward of the front axle and extended 49.0 cm (19.3 in) rearward along the left side plane. The maximum crush was 2.5 cm (1.0 in).

CDC:	Impact 1: 11FDEW2 Impact 2: 09LYEW1	
Delta V (impact 1):	Total	30.0 km/h (18.6 mph)
	Longitudinal	-28.2 km/h (-17.5 mph)
	Latitudinal	10.3 km/h (6.4 mph)
	Energy	78,962 joules (58,239 ft-lbs)

Figure 5. Front impact to Crown Victoria

Figure 4. Left side, side slap impact

Interior Damage - 1997 Ford Crown Victoria

The 1997 Ford Crown Victoria sustained minor interior damage. There was the normal damage to the steering wheel and instrument panel found after air bag deployments. The left upper quadrant of the windshield was fractured by the driver's left hand. The center mirror was dislodged by the deploying passenger air bag.

Figure 6. Contact damage to windshield and dislodged center mirror

MANUAL RESTRAINT SYSTEMS - 1997 Ford Crown Victoria

The six passenger 1997 Ford Crown Victoria was configured with manual 3-point lap and shoulder belts for the outboard seating positions and manual lap belts for the middle seat positions. The front lap and shoulder belts were equipped with adjustable D rings; the driver's was adjusted to the full down position, the right to the full up position. The driver's seat belt was configured with a sliding latch plate and an emergency locking retractor (ELR). While there was some indication of historical usage, it was not used in this crash. The front right passenger seat belt was configured with a sliding latch plate and a switchable retractor that was found in the ELR mode at the time of inspection. The seat belt was being used with the CSS at the time of the crash. Load creases were located on the webbing near the D ring. The rear outboard seats were configured with sliding latch plates and switchable ELR/ALR retractors. The front and second seat middle lap belts were configured with sewn on latch plates.

Figure 7. Load marks to front right seat belt webbing

FRONTAL AIR BAG SYSTEM - 1997 Ford Crown Victoria

The Crown Victoria was equipped with dual front air bags that deployed at impact with the Blazer. The driver's air bag module was mounted in the center of the steering wheel and had an H configuration. The top cover measured 9.0 cm (3.5 in) high by 16.0 cm (6.3) wide. The bottom cover measured 8.0 cm (3.1 in) high by 16.0 cm (6.3 in) wide. The air bag was circular in shape and measured 54.0 cm (21.3 in) in its deflated state. There were two internal tethers and two circular vent ports (11 and 1 o'clock position). There were eight vertical folds across the face of the air bag. There was no damage to the module cover or the air bag itself.

Figure 8. Driver's air bag / hand contact to windshield

The front right passenger air bag module was a mid mount design which incorporated a horizontally oriented single flap tear seam at the bottom. The module cover measured 39.5 cm (15.6 in) wide, 15.5 cm (6.1 in) high in the center, and 14.0 cm (5.5 in) high at each end. The air bag face was roughly rectangular and measured 72.0 cm (28.3 in) wide seam to seam and 62.0 cm (24.4 in) high seam to seam. There were blood drops found near the right seam. There were side panels on the left and the right. The panels were both oval in shape and measured 52.0 cm (20.5 in) high by 30.0 cm (11.8 in) wide. There was a single circular vent port in the left side panel. The upper portion of the left side panel was abraded by the center mirror during the deployment. The mirror was knocked off. There was a skin contact found 12.0 cm (4.7 in) from the bottom seam and 30.0 cm (11.8 in) from the right seam. The skin contact was approximately 3.5 cm (1.4 in) in width.

Figure 9. Left panel, front right passenger air bag

Figure 10. Left side panel, mirror and mirror contact

Figure 11. Blood drops along right hand seam

Figure 12. Skin contact to bottom of front right passenger air bag

Figure 13. Lateral view of skin contact to bottom of front right passenger air bag

CHILD SAFETY SEAT - 1997 Ford Crown Victoria

The 3-year-old male front right occupant was seated in a Cosco High Back Booster seat (Model: 22-200) with a manufacture date of 12/4/2002. When used with the internal car seat harness, the manufacturer recommends that this seat be used only by children who weigh between 10-18 kg (22-40 lbs) and whose height is 74-102 cm (29-40 in). This child seat was appropriate for the child in this case given his height (102 cm/40 in) and weight (14 kg/30 lbs). The child was wearing the five-point booster seat harness. This is based on information from emergency rescue personnel and the indications of loading at the right upper slot. The seat was anchored to the vehicle using the available lap and shoulder belt. At the time of the inspection, the booster seat had been placed back in the vehicle and anchored to the vehicle by placing the lap and shoulder belt around the seat; however, the police indicated that the lap and shoulder belt had been installed correctly (routed through the back of the booster seat). The seat belt was equipped with a sliding latch plate. The shoulder belt anchorage was adjusted to the full up position. It is not known if the switchable lap and shoulder belt was in the ALR or ELR mode at the time of the crash[1]. The booster seat was anchored to the fabric covered bucket seat. The seat back was slightly reclined. The seat track was found in the full back position (50.0 cm/19.7 in rearward of the toe pan).

Figure 14. Cosco High Back Booster seat

[1]The seat was removed from the vehicle by bystanders to treat the child. The investigating officer found the lap and shoulder belt in the fully extended position.

The front right passenger air bag had a maximum deflated excursion of 73.0 cm (28.7 in). The distance from the module face to CSS back and vehicle seat back were 68.0 cm (26.8 in) and 74.0 cm (29.1 in), respectively.

Figure 15. Overview of booster seat position relative to front right passenger air bag as viewed from left

Figure 16. Overview of booster seat position relative to front right passenger air bag as viewed from right

Other vehicle

Description:	1997 Chevrolet Blazer sport utility vehicle	
VIN:	1GNDT13W5V2xxxxxx	
Odometer:	Unknown	
Engine:	4.3 liter, 6 cylinder	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description[2]:	Direct contact damage to front right, extending from the bumper corner longitudinally down the right side to mid front door. Secondary impact damage to right rear corner.	
CDC:	Unknown	
Delta V (impact 1):	Total	43.7 km/h (27.1 mph)
	Longitudinal	-21.8 km/h (-13.6 mph)
	Latitudinal	-37.8 km/h (-23.5 mph)
	Energy	207,172 joules (152,802 ft lbs)

[2]Based on police report information.

Occupants

Case vehicle	Driver	Occupant 2
Age/Sex:	28/Male	3/Male
Seated Position:	Front left	Front right
Seat Type:	Fabric covered split bench, seat adjusted to full back track position	Fabric covered split bench, seat adjusted to full back track position
Height:	168 cm (66 in)	102 cm (40 in)
Weight:	91 kg (200 lbs)	14 kg (30 lbs)
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Unknown	Unknown
Foot Position:	Right foot on brake, left on floor board	Unknown
Restraint Usage:	3-point manual lap and shoulder belt, not used	3-point manual lap and shoulder belt, in unknown locking mode, used with forward facing high back booster CSS
Air bag:	Steering wheel mounted driver’s air bag, deployed	Mid instrument panel mounted front right passenger air bag, deployed

Other vehicle

Age/Sex:	43/Female
Seated Position:	Front left
Seat Type:	Bucket
Height:	163 cm (64 in)
Weight:	56 kg (123 lbs)
Occupation:	Unknown
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:	Unknown
Restraint Usage:	Lap and shoulder belt available, used per police report

OCCUPANT INJURIES - 1997 Ford Crown Victoria

Driver: Injury obtained from emergency room notes and a radiology consult (x-rays were negative for a wrist fracture).

Injury	OIC Code	Injury Mechanism	Confidence Level
Multiple abrasions, left hand	790202.1,2	Windshield	Certain

Front right occupant: Injuries obtained from autopsy report and hospital emergency room records.

Injury	OIC Code	Injury Mechanism	Confidence Level
Cranio-cervical dislocation	640208.2,6	Passenger air bag	Certain
C5-C6 intervetrebral disc, complete transection with marked distraction. Corresponding anterior and posterior longitudinal ligaments have complete lacerations.	650299.2,6 (disc injury) dislocation) 630284.1,6 (ligament lacerations)	Passenger air bag	Certain
Neck contusion, left anterolateral inferior area, x 2	390402.1,2	Passenger air bag	Certain
Right shoulder contusion, 2.0 x 2.0 cm (0.8 x 0.8 in)	790402.1,1	CSS harness	Certain
Right axilla contusion, anteriorly, 3.0 x 3.0 cm (1.2 x 1.2 in)	790402.1,1	CSS harness	Probable
Chest contusion, 11.0 x 0.3 cm (4.3 x 0.1 in) roughly linear, obliquely oriented, with right aspect upper most	490402.1,1	CSS harness	Certain
Chest abrasion, 5.0 x 4.0 cm (1.9 x 1.6 in), centrally and inferiorly	490202.1,4	CSS harness	Certain
Contusions to brain, inferior aspect of the right and left frontal, temporal, and parietal lobes	140620.3,3	Passenger air bag	Probable

Subarachnoid hemorrhage	140684.3,2	Passenger air bag	Probable
Contusion, right lung Contusion, left lung	441450.4,3	CSS harness	Probable
Forehead abrasion, right side, 4.0 x 2.0 cm (1.6 x 0.8 in)	290202.1,7	Passenger air bag	Certain
Forehead abrasion, central, 1.0 x 1.5 cm (0.4 x 0.6 in)	290202.1,7	Passenger air bag	Certain
Abrasion, tip of nose	290202.1,4	Passenger air bag	Certain
Facial contusion, right malar region, 3.0 x 2.0 cm	290402.1,1	Passenger air bag	Certain
Facial contusion, left malar region, 2.0 x 1.0 cm (0.8 x 0.4 in)	290402.1,2	Passenger air bag	Certain
Right ear, two small contusions	290402.1,1	Passenger air bag	Certain
Chin abrasion, 2.0 x 2.0 cm (0.8 x 0.8 in)	290202.1,	Passenger air bag	Certain
Mucosal contusion	440802.2,4	Passenger air bag	Certain
Tongue contusion	243099.1,8[3]	Passenger air bag	Certain
Neck abrasion, anterior, 7.0 x 1.5 cm (2.8 x 0.6 in), horizontally oriented	390202.1,5	CSS harness	Probable

[3]Coded as non-specific mouth injury

OCCUPANT KINEMATICS - 1997 Ford Crown Victoria

Driver kinematics

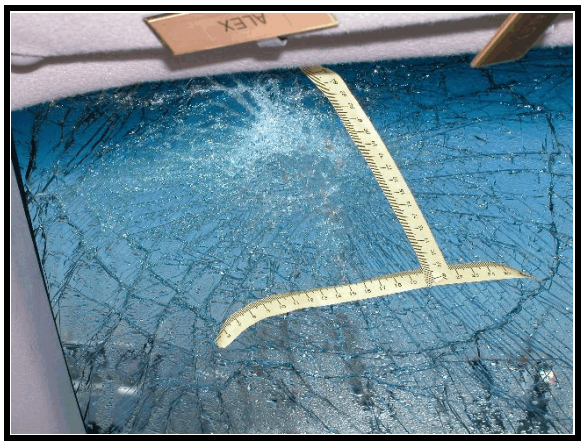

Figure 17. Driver hand contact to windshield

The 28-year-old male driver of the Ford Crown Victoria was seated in a normal, upright fashion. He was not wearing the available 3-point lap and shoulder belt. He was seated on a fabric covered split bench; the seat was adjusted to full back track position and the seat back was slightly reclined. Prior to impact, the driver was braking. His right foot was on the brake with the left on the floorboard. He was likely using both hands to brace, but this is not known for sure. At impact, the driver initiated a forward and slightly left trajectory. His face and torso likely engaged the deployed driver's air bag, but there were no resultant contacts or injuries. His left hand came off the steering wheel and struck and fractured the windshield–causing multiple hand abrasions. The driver came to rest in his seat and was able to exit the vehicle under his own power. He was transported to a local hospital where he was treated and released.

Occupant Kinematics

Figure 18. CSS harness loading

The 3-year-old male front right occupant was seated in a Cosco High Back Booster seat. He was wearing the five-point booster seat harness. This is based on information from emergency rescue personnel and the indications of loading at the right upper slot. The seat was anchored to the vehicle using the available lap and shoulder belt. The shoulder belt anchorage was adjusted to the full up position. It is not know if switchable lap and shoulder belt was in the ALR or ELR mode at the time of the crash. The booster seat was anchored to the fabric covered split bench seat. The seat back was slightly reclined. The seat track was found in the full back position (50.0 cm/19.6 in rearward of the toe pan). At impact with the Chevrolet Blazer, the child and child seat initiated forward and slightly left trajectories to the front. The child loaded the harness, likely causing the bilateral lung contusions and multiple torso abrasions. The child's head pitched forward to some degree and the child's neck engaged the child seat harness, possibly causing the horizontal anterior abrasion to the neck. The passenger side air bag deployed. The front right passenger air bag had a maximum deflated excursion of 73.0 cm (28.7 in). The distance from the module face

to the CSS back was 68.0 cm (26.8 in). The bottom of the deploying air bag engaged the child's face and neck–causing multiple abrasions. The child's head was forced rearward and was hyperflexed–causing the cranio-cervical dislocation. The child came to rest in the child seat. He was initially kept in the seat as a preventative measure and he was being given mouth-to-mouth resuscitation. He was transported by helicopter to an area trauma center where he was declared dead shortly after arrival.

Attachment 1. Scene Diagram