

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

Veridian Engineering
Calspan Operations
Buffalo, New York 14225

**CALSPAN ON-SITE AIR BAG DEPLOYMENT/CHILD PASSENGER
FATALITY INVESTIGATION
CALSPAN CASE NO. CA97-25
VEHICLE: 1995 FORD ASPIRE
LOCATION: PENNSYLVANIA
CRASH DATE: JUNE, 1997**

Contract No. DTNH22-94-D-07058

Prepared for:

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

DISCLAIMER

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 are coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

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

TECHNICAL REPORT STANDARD TITLE PAGE

<p>1. <i>Report No.</i> CA97-25</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>4. <i>Title and Subtitle</i> Calspan On-Site Air Bag Deployment/Child Passenger Fatality Investigation Vehicle: 1995 Ford Aspire Location: Pennsylvania</p>		<p>5. <i>Report Date:</i> December, 1999</p>	
		<p>6. <i>Performing Organization Code</i></p>	
<p>7. <i>Author(s)</i> Crash Research Section</p>		<p>8. <i>Performing Organization Report No.</i></p>	
<p>9. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Research Section Calspan Corporation P.O. Box 400 Buffalo, New York 14225</p>		<p>10. <i>Work Unit No.</i> CO1115.0000.(7470-7479)</p>	
		<p>11. <i>Contract or Grant No.</i> DTNH22-94-D-07058</p>	
<p>12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590</p>		<p>13. <i>Type of Report and Period Covered</i> Technical Report Incident Date: February, 1998</p>	
		<p>14. <i>Sponsoring Agency Code</i></p>	
<p>15. <i>Supplementary Notes</i> On-site investigation of a child passenger fatality crash that involved a 1995 Ford Aspire equipped with frontal air bags for the driver and passenger positions.</p>			
<p>16. <i>Abstract</i> This on-site investigation focused on the injury mechanisms and cause of death for a 3 year old male child passenger who was positioned on the lap of the front right passenger in a 1995 Ford Aspire. The Aspire was equipped with frontal air bags for the driver and right passenger which deployed as a result of an intersection-type crash with a 1983 Ford Fairmont. The driver of the Ford Aspire probably braked immediately prior to impact as the frontal area of the Aspire impacted the left passenger compartment area of the Fairmont. The Aspire underwent a velocity change of 24.8 km/h (15.4 mph) which was sufficient to deploy the frontal air bag system. The child passenger was unrestrained on the lap of the adult front right passenger and was forward, in the path of the deploying passenger air bag. The air bag contacted the right facial area of the child resulting in multiple soft tissue abrasions. The head of the child was accelerated into the front right adult passenger which resulted in a depressed skull fracture with extravasation of brain tissue. The acceleration of the head by the expanding air bag and/or the occupant-to-occupant interaction resulted in severe cerebral edema with extensive brain swelling, and a large subdural hematoma. The child was transported to a local hospital then transferred to a pediatric trauma center where he expired approximately 9.5 hours following the crash.</p>			
<p>17. <i>Key Words</i> Frontal air bag deployment Child passenger seated on lap Air bag expansion</p>		<p>18. <i>Distribution Statement</i> General Public</p>	
<p>19. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>20. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>21. <i>No. of Pages</i> 13</p>	<p>22. <i>Price</i></p>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	
Crash Data	2
VEHICLE DATA	
1995 Ford Aspire	2
1983 Ford Fairmont	2
CRASH SEQUENCE	
Pre-Crash	3
Crash	3
Post-Crash	4
VEHICLE DAMAGE	
Exterior - 1995 Ford Aspire	4
Interior	5
Exterior - 1983 Ford Fairmont	5
AUTOMATIC RESTRAINT SYSTEM	
1995 Ford Aspire	6
MANUAL RESTRAINT SYSTEMS	
1995 Ford Aspire	7
OCCUPANT DEMOGRAPHICS	
1995 Ford Aspire	
DRIVER	8
FRONT RIGHT ADULT PASSENGER	8
FRONT RIGHT CHILD PASSENGER	9
REAR SEAT CHILD PASSENGERS	12

**CALSPAN ON-SITE AIR BAG DEPLOYMENT/
CHILD PASSENGER FATALITY INVESTIGATION
CALSPAN CASE NO. CA97-25
VEHICLE: 1995 FORD ASPIRE
LOCATION: PENNSYLVANIA
CRASH DATE: JUNE, 1997**

BACKGROUND

This on-site investigation focused on the injury mechanisms and cause of death for a 3 year old male child passenger who was positioned on the lap of the front right passenger in a 1995 Ford Aspire. The Aspire was equipped with frontal air bags for the driver and right passenger which deployed as a result of an intersection-type crash with a 1983 Ford Fairmont (**Figure 1**). The driver of the Ford Aspire probably braked immediately prior to impact as the frontal area of the Aspire impacted the left passenger compartment area of the Fairmont. The Aspire underwent a velocity change of 24.8 km/h (15.4 mph) which was sufficient to deploy the frontal air bag system. The child passenger was unrestrained on the lap of the adult front right passenger and was forward, in the path of the deploying passenger air bag. The air bag contacted the right facial area of the child resulting in multiple soft tissue abrasions. The head of the child was accelerated into the front right adult passenger which resulted in a depressed skull fracture with extravasation of brain tissue. The acceleration of the head by the expanding air bag and/or the occupant-to-occupant interaction resulted in severe cerebral edema with extensive brain swelling, and a large subdural hematoma. The child was transported to a local hospital then transferred to a pediatric trauma center where he expired approximately 9.5 hours following the crash.



Figure 1. Final rest position of the involved vehicles.

It should be noted that this child should have been restrained in a forward facing child safety seat in the rear seat of the vehicle. The Ford Aspire was not a proper fit for this family of three children as the vehicle was configured with four designated seated positions.

NHTSA was notified of the crash on July 1, 1997, by the hospital where the child passenger expired. The notification was immediately forwarded to the Calspan Special Crash Investigation team and assigned as an on-site investigation due to the fatal outcome of the front seat child passenger. Travel arrangements were initiated and an on-site investigation was conducted on July 2, 1997.

SUMMARY

Crash Site

The crash occurred on a two lane urban street with a dual direction left turn lane designated by painted markings. The asphalt travel lanes were 10.4 m (34.0') in width, inclusive of the left turn lane. Both travel lanes were bordered by wide paved shoulders with commercial driveways intersecting the shoulders. The roadway was straight with a positive grade of 1 percent to the east (**Figure 2**). At the time of the crash, the viewing conditions were daylight, the weather was clear, and the environmental surfaces were dry. The crash occurred in a mid block area with a posted speed limit of 72 km/h (45 mph). The Crash Schematic is attached as **Figure 14**, Page 13.



Figure 2. Overall view of the crash site and trajectory of the Ford Aspire.

VEHICLE DATA

1995 Ford Aspire

The subject vehicle in this crash was a 1995 Ford Aspire that was equipped with frontal air bags for the driver and right passenger positions. The vehicle was a 5-door hatchback that was manufactured for Ford Motor Company by Kia Motors, Inc. of Korea. The power train consisted of a 1.3 liter transverse mounted 4-cylinder engine linked to an automatic transmission with a floor mounted shifter. Standard equipment included power-assisted front disc/rear drum brakes, and power-assisted steering. The vehicle was identified by vehicle identification number KNJLT06HXS6 (production number deleted). The gross vehicle weight rating for this 4-passenger rated vehicle was 1,339 kg (2,952 lbs). At the time of the crash, the vehicle's odometer had recorded 26,707.8 km (16,595.9 miles).

As previously noted, the interior of the Aspire was configured as a 4-passenger vehicle. The front bucket seats had integral head restraints, manual track adjusters, and reclining seat back supports. The rear bench seat was equipped with a forward folding backrest to facilitate cargo through the rear hatch area. All four seated positions were equipped with manual 3-point lap and shoulder belt systems.

1983 Ford Fairmont

The struck vehicle in this crash was a 1983 Ford Fairmont Futura, 4-door sedan. The Ford was powered by a 3.3 liter in-line 6-cylinder engine coupled to an automatic transmission with a column mounted shifter. The Fairmont was equipped with 3-point lap and shoulder belts for the front outboard seated positions and lap belts for the center front and three rear seat positions. The vehicle was identified by vehicle identification number 1FABP36X0DK (production number deleted). At the time of the crash, the odometer reading was 127,767 km (79,393 miles).

CRASH SEQUENCE

Pre-Crash

The 27 year old male driver of the 1995 Ford Aspire had rented the vehicle in New Jersey and was traveling to the area of the crash in Pennsylvania for a scheduled appointment. He was traveling with a 20 year old female passenger seated in the front right position of the vehicle and three male children, ages 3, 5, and 6 years of age. The 3 year old was positioned on the lap of the front right passenger while the other children were seated in the rear seat of the Aspire. As the driver arrived at the location of his appointment, he found the building unoccupied. He exited the location and was proceeding in an easterly direction on the two lane road in search of a telephone. The driver pulled into a parking lot located approximately 40 m (130') west of the impending crash site in search of a telephone, however, not locating a phone, he immediately re-entered the travel lane to proceed in an easterly direction. He approached the crash site at a speed that was estimated to be below the posted speed limit of 72 km/h (45 mph).

The driver of the Ford Fairmont was attempting to exit a driveway located at the south side of the roadway. He stated to the investigating officer that he checked for approaching traffic in both directions prior to accelerating into the eastbound travel lane, initiating a left turn maneuver to proceed in a westerly direction.

Crash

Although unconfirmed by physical evidence at the crash scene, the driver of the Ford Aspire probably initiated avoidance actions immediately prior to the crash by braking. The full frontal area of the Aspire impacted the left side of the Ford Fairmont in an intersection-type collision sequence. Impact speeds were computed by the damage and trajectory algorithm of the WinSMASH at 44.0 km/h (27.3 mph) for the Aspire and 24.2 km/h (15.0 mph) for the struck Ford Fairmont. Resultant directions of force were within the 01 o'clock sector for the Aspire and 10 o'clock for the Fairmont. Velocities changes were computed by the WinSMASH program and are identified in **Table 1**.

Table 1. WinSMASH Output

	Ford Aspire	Ford Fairmont
Impact Speed	44.0 km/h (27.3 mph)	24.2 km/h (15.0 mph)
Total Delta V	24.8 km/h (15.4 mph)	18.3 km/h (11.4 mph)
Longitudinal Delta V	-23.4 km/h (-14.5 mph)	-7.9 km/h (-4.9 mph)
Lateral Delta V	-8.2 mk/h (-5.1 mph)	17.1 km/h (10.6 mph)
Energy Dissipation	14,445 joules	38,889 joules

The Ford Aspire underwent a velocity change of 24.8 km/h (15.4 mph) with a longitudinal component of -23.4 km/h (-14.5 mph). The longitudinal component was sufficient to deploy the vehicle's frontal air bag system.

As the vehicles crushed to maximum engagement, the lateral component of the 1 o'clock impact force rotated the Aspire approximately 27 degrees in a counterclockwise (CCW) direction as its center of gravity (CG) continued approximately 3 m (10') forward in an easterly direction. The vehicle came to rest diagonal to the eastbound travel lane with the frontal area straddling the painted delineation for the center left turn lane.

The Ford Fairmont was rotated approximately 57 degrees in a CCW direction and displaced approximately 2.4 m (8.0') east of its at impact position. At rest, the Fairmont was entirely in the center left turn lane, facing in a westerly direction.

Post-Crash

Immediately following the crash, the driver of the Ford Aspire detected the injured state of the 3 year old male front passenger. He exited the vehicle and removed the child passenger from the vehicle and began to run around the scene with the child. He subsequently placed the child on the grassy area adjacent to the roadway and waited for emergency personnel to arrive on-scene. The occupants of Ford Fairmont exited the vehicle without assistance and waited for police to arrive on-scene.

Emergency medical personnel arrived on-scene and transported the injured child to a local hospital where he was evaluated and prepared for helicopter transport to a pediatric children's trauma center. At this facility, the child was diagnosed with brain death and was placed on a ventilator. He subsequently expired approximately 9.5 hours post-crash. His family consented to organ donation of his heart and liver.

VEHICLE DAMAGE

Exterior - 1995 Ford Aspire

The Ford Aspire sustained moderate frontal damage as a result of its impact sequence with the side of the Ford Fairmont. Maximum crush was 13.7 cm (5.4") located at the front left corner of the bumper. The direct contact damage began 51.4 cm (20.25") right of center and extended 120.9 cm (47.6") to the front left corner (Figure 3). The combined induced and direct contact damage involved the full frontal width of the vehicle and was measured at 134.6 cm (53.0"). The crush profile was documented at the level of the bumper fascia and was as follows (Figure 4): C1 = 13.7 cm (5.4"), C2 = 11.7 cm (4.6"), C3 = 9.5 cm (3.75"), C4 = 7.4 cm (2.9"), C5 = 2.3 cm (0.9"), C6 = 1.9 cm (0.75").



Figure 3. Direct contact damage to the Ford Aspire.



Figure 4. Profile view of the frontal crush.

Damaged components included the front bumper fascia and reinforcement system, hood, and the right front fender. The Collision Deformation Classification (CDC) for this impact event was 01-FDEW-1.

Interior

The interior damage to the Ford Aspire was limited to air bag deployment, occupant contact, and displacement of beverage containers within the vehicle. There was no damage related to exterior deformation or intrusion of interior components.

The windshield was cracked and scuffed with a probable tissue transfer from the driver's right hand. This contact point was located 31.8-41.7 cm (12.5-16.4") left of center and 13.3-16.8 cm (5.25-6.6") above the upper instrument panel. A left hand wipe mark on the top surface of the instrument panel began at the leading edge of the panel and extended 10.8 cm (4.25") forward, terminating at the windshield. Several areas of exhaust gas residue are discussed in the Automatic Restraint System section of this report.

The driver's right knee contacted the base of the steering column which scuffed the plastic component. The contact was located 21.0-31.8 cm (8.25-12.5") left of center and 30.5-35.6 cm (12.0-14.0") below the top of the left instrument panel. A faint brownish-type scuff mark was located on the left upper quadrant of the driver air bag. The scuff was located 5.7-12.7 cm (2.25-5.0") left of the bags centerline and 8.4-17.8 cm (3.3-7.0") above the horizontal centerline. There was no compression of the energy absorbing steering column.

The front passenger air bag module cover flap impacted and cracked the laminated windshield 17.1-41.9 cm (6.75-16.5") right of center. Exhaust gases venting from the lateral port of the passenger air bag were deposited on the right upper A-pillar. At the base of the windshield, a whitish scuff mark (possible tissue transfer) was noted 29.2-33.7 cm (11.5-13.25") right of center and 1.3-5.7 cm (0.5-2.25") above the upper instrument panel. This transfer possibly resulted from a left hand contact by the child passenger.

A large lipstick transfer was noted to the face of the deployed passenger air bag. The expansion of the air bag against the child passenger and the front right adult passenger resulted in an altered deployment path of the bag membrane. The bag probably contacted the interior rear view mirror which displaced the mirror to the vehicle's left.

Exterior - 1983 Ford Fairmont

Exterior damage to the Ford Fairmont was located on the left side of the vehicle at the doors between the A- and C-pillars (**Figure 5**). The direct contact damage began 81.3 cm (32.0") rearward of the left front axle and extended 143.5 cm (56.5") to the left C-pillar. The damage deformed both front doors resulting in a combined induced and direct damage length of 199.4 cm (78.5"). Maximum crush was 31.1 cm (12.25") located at the mid aspect of the lower left front door panel at the C4 location. The crush profile at the level was as follows: C1 = 0 cm, C2 = 8.3 cm (3.25"), C3 = 21.6 cm (8.5"), C4 = 31.1 cm (12.25"), C5 = 19.7 cm (7.75"), C6 = 0 cm.



Figure 5. Ford Fairmont's damage pattern.

AUTOMATIC RESTRAINT SYSTEM

1995 Ford Aspire

The Ford Aspire was equipped with a Supplemental Restraint System (SRS) that consisted frontal air bags for the driver and right passenger positions (**Figure 6**). The driver air bag deployed from an H-configuration module assembly that was housed within the four spoke steering wheel assembly. The upper module cover flap was 14.6 cm (5.75") in width at the horizontal tear seam and 7.0 cm (2.75") in height while the lower flap had respective dimensions of 14.6 cm (5.75") and 8.3 cm (3.25"). The deployed air bag was constructed of two panels sewn with an internal peripheral seam and was a pinkish fabric that was 64.8 cm (25.5") in diameter. The identification numbers 075437C were stamped onto the panel exposed to the driver while the forward panel was stamped with 096439C. The bag was tethered internally by four tether straps sewn to the face of the bag with a 18.0 cm (7.1") diameter reinforcement. The bag was vented by two 3.8 cm (1.5") diameter ports located at the 10 and 2 o'clock positions. The vent ports were centered 18.4 cm (7.25") forward of the peripheral seam, or 8.9 cm (3.5") outboard of the inflator.



Figure 6. Overall view of the Aspire's deployed frontal air bag system.



Figure 7. Air bag exhaust gas burn to the upper instrument panel.

A faint brownish-type scuff was vertically oriented on the face of the driver bag 5.7-12.7 cm (2.25-5.0") right of center and 8.6-17.8 cm (3.4-7.0") above the horizontal centerline. The vent ports exhausted the hot gas and particulates onto the upper instrument panel and the windshield. A large grayish burn area from the right vent port was located on the upper instrument panel (**Figure 7**), above the instrument cluster, located 25.4-33.0 cm (10.0-13.0") left of center and 2.8 cm (1.1") vertically, extending 5.4 cm (2.25") forward on the top panel. A second exhaust gas transfer was located on the windshield 26.7-34.3 cm (10.5-13.5") left of center and 7.6-15.2 cm (3.0-6.0") above the defroster vents. It should be noted that at the time of the SCI inspection, three finger prints were present in this transfer. The left vent port exhausted onto the top left quadrant of the knee bolster, located 49.5-57.2 cm (19.5-22.5") left of center and 24.1-29.2 cm (9.5-11.5") below the top of the instrument panel.

The front passenger air bag was mounted in the right instrument panel in a mid mount (**Figure 8**) configuration. The single cover flap was 32.0 cm (12.6") in length and 19.1 cm (7.5") in height. The top hinge point was located at the upper instrument panel while the horizontal tear seam was at the mid panel. The cover flap opened in an upward direction and fractured the windshield (**Figure 9**) 17.1-41.9 cm (6.75-16.5") right of center and 15.2-17.8 cm (6.0-7.0") above the instrument panel.



Figure 8. Deployment of the passenger air bag from its mid mount position.



Figure 9. Front right passenger air bag cover flap contact to the windshield.

The front passenger air bag measured 48.3 cm (19.0") vertically and 39.4 cm (15.5") horizontally in its deployed and deflated state. The side profile of the bag consisted on a throat that protruded 17.8 cm (7.0") outboard of the inflator and 15.2 cm (6.0") in height. The bag tapered to its above dimensions over a depth of 33.0 cm (13.0"). The bag was not tethered internally. Venting was achieved by two ports located on the side panels at the 3 and 9 o'clock positions. The ports were 2.9 cm (1.25") in diameter and centered 15.3 cm (6.0") outboard of the mid instrument panel. Air bag residue that exhausted from the right vent port was noted to the right upper A-pillar, 33-56 cm (13-22") above the beltline.

Several areas of occupant contact were noted to the face of the front right passenger air bag. A lip stick transfer from both lips was located on the left midpoint of the bag which extended 17.6-12.1 cm (3.0-4.75") right of the left side of the bag and 17.1-19.7 cm (6.75-7.75") below the top apex of the bag. This transfer subsequently smeared to the lower left corner of the bag extending 31.8 cm (12.5") below the referenced apex and 7.0-10.8 cm (2.75-4.25") right of the left seam. There was no damage, burns, or tears to the membrane of the bag.

MANUAL RESTRAINT SYSTEMS

1995 Ford Aspire

The Aspire was equipped with three-point lap and shoulder belt systems for the four outboard seated positions. The Aspire was a four passenger vehicle, therefore no center lap belt was available.

The front belt systems consisted of a continuous loop webbings with sliding latchplates and dual mode locking retractors incorporated into the lower B-pillars of the vehicle. The upper anchorages (D-rings) were fixed. An energy management loop was stitched into the lower aspect of the lap belt webbings and concealed by a plastic sleeve. Both front management loops were intact and not deployed.

The front left (driver) belt system did yield evidence of frequent usage, both on the latchplate and the edges of the webbing. This usage was not driver related since the vehicle was a rental car. The passenger belt system yielded faint evidence of routine usage. Both front belt systems were not worn during this crash.

The left rear belt was captured between the seat back rest and the C-pillar at the time of the SCI inspection. There were no usage indicators on the rear belt systems. Both rear seat child passengers were allegedly restrained by the belt systems. This could not be verified or disputed due to the lack of restraint loading and contact points in the rear seat area.

OCCUPANT DEMOGRAPHICS

Driver - 1995 Ford Aspire

Age/Sex: 27 year old male
Height: Unknown
Weight: Unknown
Manual Restraint
Use: None
Usage Source: Vehicle inspection
Type of Medical
Treatment: None

Driver Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanism
Complaint of pain of the upper extremities	N/A, not codeable under AIS 90	Windshield (probable)

Driver Kinematics

The driver of the Ford Aspire was seated in a presumed normal posture with the seat track adjusted to the full rear position. He was not wearing the manual 3-point lap and shoulder belt system. The lack of restraint usage was determined from contact evidence within the vehicle and the non-deployment status of the energy management loop.

At impact, the driver initiated a forward trajectory in response to the 1 o'clock impact force (**Figure 10**). His right knee loaded the base of the steering column which produced a scuff mark to the plastic component. No injury was reported from this contact point. His left hand separated from the steering wheel rim and wiped across the upper instrument panel. His right hand subsequently impacted and cracked the windshield 31.8-41.7 cm (12.5-16.4") left of center. The driver complained of upper extremity pain which probably resulted from this contact.



Figure 10. Trajectory and contact points of the driver.

FRONT RIGHT ADULT PASSENGER

Age/Sex: 20 year old female
Height: Unknown
Weight: Unknown
Manual Restraint
Usage: None
Usage Source: Vehicle inspection
Mode of Transport
From Scene: Ambulance to a local hospital
Type of Medical
Treatment: Treated and released with follow-up to a chiropractor

Front Right Adult Passenger Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanism
Generalized bulging of the disc at C6-C7 *	Moderate (650299.2,6)	Occupant-to-occupant interaction with child passenger/impact force
Central focal herniation at L4-L5 causing anterior compression of the thecal sac at this level *	Moderate (650600.2,8)	Occupant-to-occupant interaction with child passenger/impact force

* Source - Chiropractic service with MRI scans

Front Right Adult Passenger Kinematics

The front right adult passenger was seated in a presumed normal posture with the seat track adjusted to the full rear position at the time of the SCI inspection of the vehicle. The seat back support was found adjusted to the most vertical position. This passenger was holding a 3 year old female child occupant on her lap. Based on contact evidence within the vehicle, it appears that the child may have been sitting on the right side of the passenger’s lap.

At impact, the frontal air bag system deployed. The expanding air bag membrane contacted the forward positioned child occupant. This passenger subsequently contacted the left aspect of the air bag as evidenced by a large lipstick transfer to the left side of the air bag membrane (**Figure 11**). The child passenger was probably displaced in a rearward direction by the expanding air bag, impacting the adult passenger. This occupant-to-occupant interaction could have contributed to the cervical and lumbar injuries sustained by this passenger. There were no reported soft tissue injuries directly related to this interaction.



Figure 11. Lipstick transfer to the left side of the passenger air bag.

FRONT RIGHT CHILD PASSENGER

Age/Sex: 3 year old male
 Height: 96.5 cm (38.0")
 Weight: 20.4 kg (45.0 lb)
 Manual Restraint
 Usage: None
 Usage Source: Vehicle inspection, driver statements to the investigating officer
 Mode of Transport
 From Scene: Ambulance to a local hospital
 Type of Medical
 Treatment: Treated at the local hospital and transferred by helicopter to a pediatric children’s trauma center where he expired approximately 9.5 hours following the crash

Front Right Child Passenger Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanism
Severe cerebral edema with extensive brain swelling of the inferior cerebral hemispheres with obliteration of the basal cisterns	Critical (14067.5,9)	Acceleration injury from the expanding air bag membrane and/or occupant-to-occupant interaction
Large fronto-parietal subdural hematoma with midline shift to the right and subfalcian herniation	Critical (140446.5,6)	Acceleration injury from the expanding air bag membrane and/or occupant-to-occupant interaction
Depressed (4 mm) fracture of the lateral left occipital bone with extravasation of brain tissue	Severe (150406.4,6)	Occupant-to-occupant interaction
Upper right eyelid laceration with abrasion	Minor (297602.1,1; 297202.1,1)	Deploying front right air bag membrane
Ecchymosis of the posterior right shoulder	Minor (790402.1,1)	Occupant-to-occupant interaction
Irregular abrasions up to 2.5 cm across the right forehead, right eyebrow, right orbit, tip of the nose and onto the right cheek	Minor (290202.1,7; 290202.1,7; 297202.1,1; 290202.1,4; 290202.1,1)	Deploying front right air bag membrane

Front Right Child Passenger Kinematics

The 3 year old male child passenger was positioned on the lap of the front right occupant. Although a 3-point lap and shoulder belt system was available for the adult occupant, the restraint system was not in use. This was determine from the lack of loading evidence on the belt system and statements by the driver to the investigating officer. A large lipstick transfer from the adult front seat passenger was located on the left side of the front passenger air bag, therefore this child passenger was probably positioned on the right leg of the adult passenger.

Immediately prior to the crash, the driver of the Ford Aspire probably braked in an attempt to avoid the impending impact. This braking action would have displaced the child passenger in a forward direction, positioning his head in a close proximity to the mid mount front right air bag. As the air bag system

deployed (**Figure 12**), the air bag membrane contacted the child in the right upper facial area producing abrasions of the forehead, right eye and the right cheek. These soft tissue injuries were noted in the medical examiner's report. Hospital records identified a laceration with abrasion of the right eyelid. The location of this abrasion pattern indicates the child passenger's head was turned to the left as the air bag deployed. His left face was free of abrasion, thus supporting the head position. Additionally, the child passenger did not sustain soft tissue injury of the neck and/or cervical injuries. The lack of these injuries was attributed to his low position within the vehicle which probably supported the child being seated on the lap versus standing on the seat cushion.

The expansion of the air bag membrane (**Figure 13**) displaced the child passenger rearward into the front right passenger. His direct contact with the passenger resulted in the depressed skull fracture of the left occipital bone and ecchymosis of the right posterior shoulder. In addition to these injuries, the child passenger sustained severe cerebral edema with extensive brain swelling and a large fronto-parietal subdural hematoma. These injuries could have resulted from the air bag induced acceleration of the head, or from the contact with the adult passenger, or both mechanisms.

The child passenger came to rest in the lap of the front right passenger. Immediately following the crash, the driver exited the vehicle and removed the child from the vehicle. He initially ran about the scene of the crash with the child in his arms prior to lying the child on the grassy area near the crash site.



Figure 12. Deployment of the front right passenger air bag.



Figure 13. Profile view of the front right passenger air bag.

Medical Treatment

The child passenger was initially treated at the scene by paramedics and transported by ambulance to a local hospital. He arrived approximately 17 minutes following the crash with a Glasgow Coma Score (GCS) of 4. Initially, the child responded to painful stimuli. Various CT scans of the head, neck, chest, and pelvis were taken which identified the head injuries. The attending physicians recommended transfer of the child to a children's trauma center. He was prepared and transported by helicopter, arriving approximately 3.5 hours after the crash with GCS of 4.

The child was evaluated and admitted to surgery for a craniotomy and drainage of the hematoma with placement of an ICP. The child's clinical exam following the operation was consistent with brain death. The family was consulted of the grave prognosis of the child. He was transferred to the intensive care unit. He expired on the evening of the crash, approximately 9.5 hours post-crash. The family consented to organ donation of his liver and heart.

REAR SEAT CHILD PASSENGERS

The rear seat of the Ford Aspire was occupied by a 6 year old male in the left rear position and a 5 year old male in the right rear position. The driver alleged that both occupants were restrained by the available manual belt systems, however, there was no evidence to support belt usage, or the lack of belt usage. The children were not injured and no contact evidence was noted to the rear of the front seat back supports.

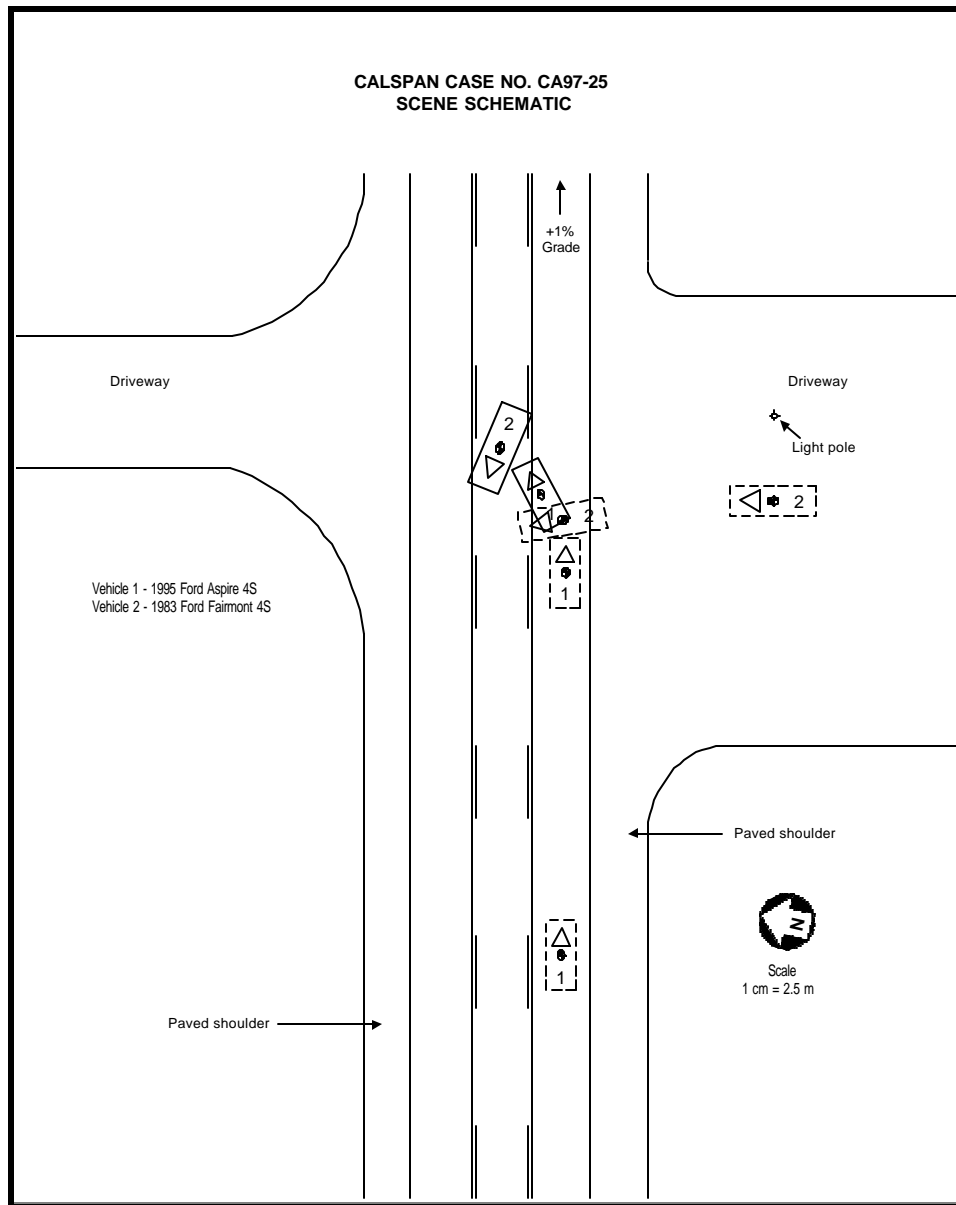


Figure 14. Crash schematic