

January 12, 2001

**TRANSPORTATION RESEARCH GROUP
CRASH RESEARCH SECTION**

VERIDIAN ENGINEERING
(FORMERLY CALSPAN SRL CORPORATION)
BUFFALO, NEW YORK 14225

ON-SITE FATAL AIR BAG DEPLOYMENT INVESTIGATION

VERIDIAN ENGINEERING CASE NO. CA99-043

**VEHICLE #1 - 1996 CHRYSLER CONCORDE LX
VEHICLE #2 - 1995 HYUNDAI ELANTRA GLS**

LOCATION - STATE OF GEORGIA

CRASH DATE - SEPTEMBER, 1999

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 205900

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> CA99-043</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> Veridian Engineering Remote Air Bag Deployment Investigation Vehicle #1 - 1996 Chrysler Concorde LX Vehicle #2 - 1995 Hyundai Elantra GLS Location - State of Georgia</p>		<p>5. <i>Report Date:</i> February, 2000</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> Veridian Engineering Transportation Research Group Crash Research Section P.O. Box 400 Buffalo, New York 14225</p>		<p>10. <i>Work Unit No.</i> C01115.0249.(0000-0009)</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 Crash Date: September, 1999</p>	
		<p>14. <i>Sponsoring Agency Code</i></p>	
<p>15. <i>Supplementary Notes</i> On-site investigation of a front to rear crash which deployed the air bag system resulting in fatal injuries to a 7 year old female.</p>			
<p>16. <i>Abstract</i> This crash involved the front of a 1996 Chrysler Concorde LX equipped with dual front air bags and the rear of a 1995 Hyundai Elantra GLS. The Chrysler which was designed with five seats was transporting seven occupants in response to a mandatory evacuation order related to an impending life threatening weather storm. There were four children occupants in the rear seat row of the vehicle, an adult female in the front right seat and her 7 year old daughter in front of her on the leading edge of the seat cushion. The front of the Chrysler struck the rear of the Hyundai at a low speed which resulted in the deployment of the dual frontal air bag system. The damage routine of the WinSMASH speed reconstruction program computed the total delta V for the Chrysler as 10.1 km/h (6.3 mph) and 14.4 km/h (8.9 mph) for the Hyundai.</p> <p>During pre-crash braking, the child moved forward and was within close proximity to the instrument panel at the time of air bag actuation. The front right air bag contacted the child's neck and facial area which resulted in abrasions and contusions of the left anterior neck and a complete separation fracture of C1 from the base of the skull with complete cord transection (AIS-6). There was a correlating heavy concentration of body tissue noted on the surface of the air bag. She was transported to a medical treatment facility where she was pronounced deceased 45 minutes after the crash.</p> <p>The mother reported that she had suffered two fractures of the left "cheek" bone, nerve damage along the left side of her face, a blood clot adjacent to the left eye, and impaired vision of the left eye. These injuries were the result of contact between the child and the mother as the child was propelled rearward by the expanding air bag. The 37 year old male driver in the Chrysler was reportedly wearing the three point manual lap and torso restraint belt. He was not injured in the crash. The four children seated in the rear seat area ranged in age form 9-14 years old. None of these children were injured in the crash.</p> <p>The Hyundai was occupied by the 39 year old female driver, a 47 year old female front right occupant, and a 72 year old rear left female occupant. They were not injured in the crash..</p>			
<p>17. <i>Key Words</i> Dual front impact air bag deployment Total delta V 10.1 km/h (6.3 mph) 7 year old female front right occupant AIS-6 (Maximum)</p>		<p>18. <i>Distribution Statement</i> General Public</p>	
<p>19. <i>Security Classification (of this report)</i> Unclassified</p>	<p>20. <i>Security Classification (of this page)</i> Unclassified</p>	<p>21. <i>No. of Pages</i></p>	<p>22. <i>Price</i></p>

TABLE OF CONTENTS

Background	1
Summary	1
Scene Schematic	2
Vehicle Data	
1996 Chrysler Concorde LX - Exterior	5
1996 Chrysler Concorde LX - CDC	6
1996 Chrysler Concorde LX - Interior	6
1995 Hyundai Elantra GLS - Exterior	8
1995 Hyundai Elantra GLS - CDC	8
Speed Reconstruction	8
Supplemental Restraint System (SRS)	9
Injury Data	11
Occupant Kinematics	13

Final Case Report
Veridian Engineering Case No. CA99-043
Front Right Air Bag Deployment Related Child Fatality
State of Georgia
September, 1999

BACKGROUND

Veridian Engineering (formerly Calspan Operations of Veridian) was notified by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) of a two vehicle crash involving an air bag equipped 1996 Chrysler Concorde LX and a 1995 Hyundai Elantra GLS. The CID was notified by the State of Florida Safety Council that a 7 year old child had suffered fatal injuries in a two vehicle low speed crash. The CID directed the Veridian Team to conduct an on-site investigation to determine the relationship between the Chrysler's deployed dual front air bag system and the injuries sustained by the child who was seated in the front right seat.

SUMMARY

This crash occurred as the driver of the 1996 Chrysler Concorde LX and his family were evacuating the coastal region of Georgia as the result of a mandatory evacuation due to impending life threatening weather conditions. There were four children occupants in the rear seat row of the vehicle, an adult female in the front right seat and her 7 year old daughter in front of her on the leading edge of the seat cushion. The front of the Chrysler struck the rear of a 1995 Hyundai Elantra GLS at a low speed which resulted in the deployment of the dual frontal air bag system. The 7 year old female in the front seat area came in contact with the deploying air bag and suffered injuries of the face and neck. She was transported to a medical treatment facility where she was pronounced deceased 45 minutes after the crash.

Two hours prior to the crash, family members gathered at their residence and formed a 6 vehicle convoy to escape the impending weather danger and to comply with mandatory evacuation orders. They had been traveling for approximately two hours in slow moving bumper to bumper traffic which involved frequent stop and go maneuvers.

The 7 year old female was originally seated on the floor immediately forward of the front right seat, but after riding in this position for a lengthy time was allowed to sit on the leading edge of the front right seat cushion between the legs of her mother while eating a snack.

The vehicle was traveling in the right lane of a four lane undivided urban roadway with a designated left turn lane in each direction when it approached a 4 leg intersection (**Figure 1**). The driver indicated that a police officer located in the center of the intersection was directing traffic and had waved him through the intersection. As the driver traveled into the intersection, he momentarily turned his attention toward the officer and away from traffic. When he returned his attention, he noticed that the Hyundai had stopped. He immediately applied full brakes and attempted a right steering maneuver. The front of his vehicle struck the rear of the Hyundai in an 50 percent offset type collision pattern where the left frontal area of the Chrysler struck the right rear area of the Hyundai.

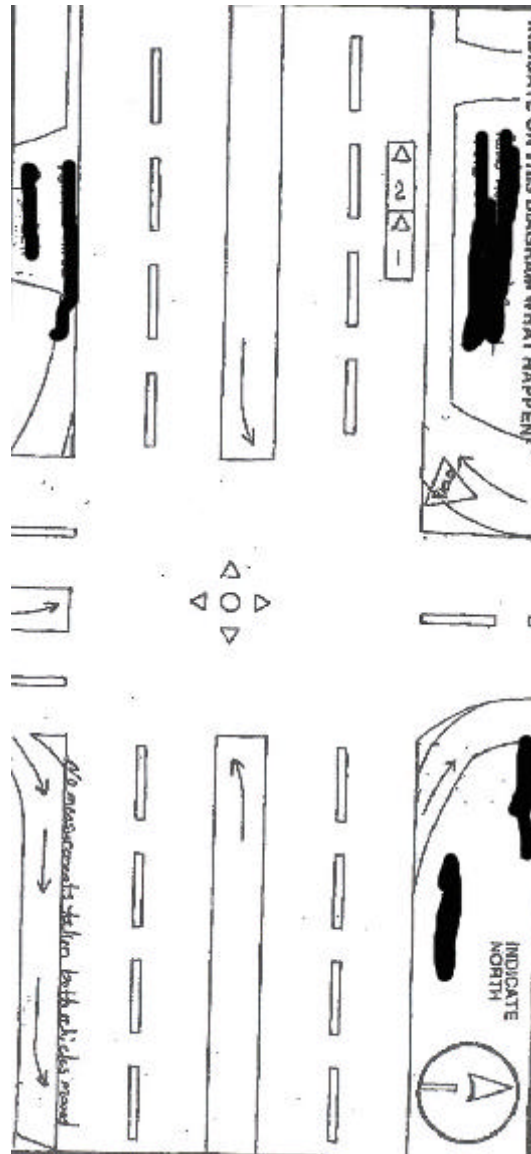


Figure 1 Police scene sketch

The crash deployed the Chrysler's supplemental restraint system (SRS) in a low delta V threshold type crash. The damage to the Chrysler was limited to 9.0 mm (0.375") displacement of the left bumper at the frame rail attachment bracket (**Figures 2 and 3**). The collision deformation classification (CDC) for this vehicle was: 12-FYEW-1. Using the damage routine of the WinSMASH speed reconstruction program, the delta V for the Chrysler was computed as 10.1 km/h (6.3 mph) and 14.4 km/h (8.9 mph) for the Hyundai.



Figure 3 Frontal view of the 1996 Chrysler Concorde LX



Figure 2 View of the left front bumper attachment bracket at the left frame rail showing 9.5 mm (0.375") of rearward displacement

Damage to the rear of the Hyundai was located in the right rear bumper area. The maximum crush of 12.8 cm (5.0") was located at the right rear bumper corner (**Figures 4 and 5**). The assigned CDC for this vehicle was 06-BZEW-1.



Figure 4 View of the rear plane of the 1995 Hyundai Elantra GLS

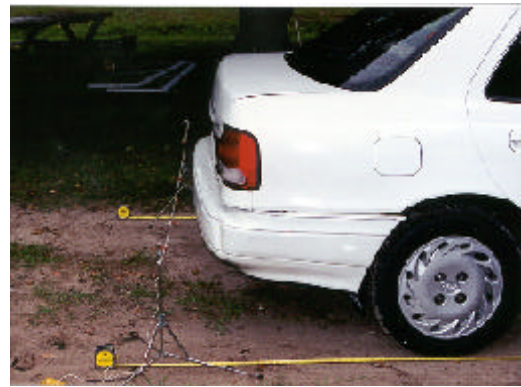


Figure 5 Lateral view of the right rear side plane showing the extent of damage (Note: string line set 3 cm long)

During pre-crash braking, the child moved forward and was within close proximity to the instrument panel at the time of air bag actuation. The front right air bag contacted the child's neck and facial area which resulted in abrasions and contusions of the left anterior neck and a complete separation fracture of C1 from the base of the skull. These medically diagnosed injuries were correlated with the heavy concentration of body tissue noted on the surface of the air bag which measured 10.2 cm (4.0") wide and 48.3 cm (19.0") long

(Figure 6). The child was subsequently propelled rearward and contacted her mother’s face with her head. The mother reported that she had suffered two fractures of the left “cheek” bone, nerve damage along the left side of her face, a blood clot adjacent to the left eye, and impaired vision of the left eye.



Figure 6 Overall and close-up view of the front right air bag showing the body tissue transfer related to contact with the child’s neck and facial area.

The child came to rest in the arms of her mother and remained there until rescue arrived approximately 6 minutes later. The mother said the child was unconscious while she held her, but was breathing and had a pulse. However, rescue was unable to detect a pulse or respiration. The child was then rapidly removed from the vehicle and transported via ambulance to a local medical treatment facility where she arrived 22 minutes after the crash and subsequently pronounced 23 minutes later.

The mother indicated that she was wearing the three point manual lap and torso belt at the time of the crash. Heavy usage wear marks on the latch plate and belt webbing indicated that the belt system was frequently used. There was no evidence of crash related usage visible on the belt system. The mother was removed by rescue and placed on a backboard and transported to the same medical treatment facility where she was treated and released.

The 37 year old male driver in the Chrysler was reportedly wearing the three point manual lap and torso restraint belt. He was not injured in the crash. The four children seated in the rear seat area ranged in age from 9-14 years old. Even though three of the four children were reportedly wearing the manual restraint belts, only the outboard lap and torso belts were visible while the center lap belt was located behind the rear seat cushion. None of these children were injured in the crash.

The Hyundai was occupied by the 39 year old female driver, a 47 year old female front right occupant, and a 72 year old rear left female occupant. The driver and the rear left occupant described the crash as extremely minor. They were not injured in the crash.

Both vehicles were driven from the scene and were still being driven at the time of this investigation. The driver of the Chrysler Concorde was issued citations for seat belt violations, following too closely, and homicide by vehicle.

VEHICLE DATA

1996 Chrysler Concorde LX - Exterior

The 1996 Chrysler Concorde was purchased as a resale vehicle 6 months prior to the crash with 58,000 km (36,000 miles) on the odometer. At the time of the crash, the vehicle odometer read 148,000 (92,000 miles). During the period of ownership, the driver indicated the vehicle had been serviced several times for various items unrelated to the supplemental restraint system (e.g., transmission, brakes, air conditioning, etc.). The driver indicated that the air bag warning lamp was not illuminated during routine driving.

The Chrysler was equipped with a dual frontal air bag system which deployed as the result of the impact with the rear plane of a 1995 Hyundai Elantra GLS. Exterior damage was limited to the left front bumper corner (**Figures 7 & 8**) which was displaced rearward 9.5 mm (0.375"). Direct contact to the front bumper measured 68.6 cm (27.0") wide which began at the vehicle centerline and extended to the left bumper corner. The only measurable crush was located at the left frame rail where the displacement of the bumper mounting bolt measured 9.5 mm (0.375"). Crush values are listed in the following table:



Figure 7 View of the left front corner



Figure 8 Lateral view of the frontal plane showing the extent of rearward displacement

1996 Chrysler Concorde LX - Crush Profile			
Impact with the 1995 Hyundai	$C_1 = 0$	$C_2 = 0$	$C_3 = 0$
	$C_4 = 0$	$C_5 = 0$	$C_6 = 9.5 \text{ mm}$ (0.375")

Collision Deformation Classification (CDC)

The collision deformation classification (CDC) code for the front impact was assigned as follows: 12-FYEW-1.

1996 Chrysler Concorde LX - Interior

Interior damage to the 1996 Chrysler Concorde LX was confined to minor scrapes along the surfaces of the front right instrument panel area, tissue transfer along the right windshield header and the associated disruption of the interior from the deployment of the air bag system. Two abraded marks which measured 11.4 cm (4.5") and 5.1 cm (2.0") in length were located on the intermediate horizontal level of the front right instrument panel adjacent to the top mounted air bag module cover, respectively. These were attributed to contact by the front right air bag during the deployment sequence (**Figure 9**). There was a 1.9 cm (0.75") diameter smudge on the vertical surface of the front right instrument panel just above the glove compartment door and 27.9 cm (11.0") right of the vehicle centerline which was attributed to contact by the child occupant during the impact sequence.



Figure 9 View of contact evidence along the front right instrument panel



Figure 10 View of scattered tissue transfer along the right windshield header area

The leading edge of the windshield header, roof liner, and right sunvisor contained small dot like artifacts which were attributed to tissue transfers related to the neck and facial soft tissue injury suffered by the front right child occupant (**Figure 10**). These artifacts were located 40.6 cm (16.0") right of the vehicle centerline and concentrated over a field width of 5.1 cm (2.0").

There were two white transfer marks, one on the center instrument panel and the other on the right instrument panel, that were attributed to previous events. The center instrument panel transfer measured 1.3 cm (0.5") in diameter and was located 12.7 cm (5.0") right of the vehicle centerline. The right instrument panel transfer which measured 1.9 cm (0.75") was located at the junction of the front right door and the corner of the intermediate horizontal surface of the front right instrument panel.

The center console exhibited a residue that was associated with a soda spill. It was not known whether this spill occurred during the crash, however, the occupants of the vehicle were reportedly taking refreshments and snacks just before the crash.

There was no visible damage noted to the front left instrument panel, knee bolster or steering wheel assembly related to the crash. The rear seat area contained four children (two restrained and two unrestrained). There was no crash related contact evidence visible.

The seat track position of the front left bucket seat was adjusted 5.7 cm (2.25") rearward from full forward over an adjustment range of 16.5 cm (6.5"). The seat back support angle measured 13 degrees rearward from vertical. In this position, the steering wheel center measured 49.5 cm (19.5") from the seat back support at a height of 41.9 cm (16.5") from the seat cushion junction. The leading edge of the seat cushion measured 30.5 cm (12.0") vertically from the floor. The seat back support had a vertical height of 55.9 cm (22.0") with an adjustable head restraint that was located in the full down position.

The front right bucket seat was found adjusted in a full rear position, but moved forward 5.1 cm (2.0") during the inspection to the approximate position described by the front right occupant prior to the crash (**Figure 11**). The front right seat adjustment range measured 21.6 cm (8.5"). The front right seat back support measured 21 degrees rearward from vertical. At this position, the seat back support measured 78.7 cm (31.0") rearward from the front right air bag module cover at a height of 140.6 cm (16.0") above the junction of the seat cushion. The leading edge of the seat cushion vertically was 30.5 cm (12.0") above the floor and 14.0 cm (5.5") rearward from the vertical plane of the instrument panel. The seat cushion had a 21 degree incline. The seat cushion measured 55.9 cm (22.0") wide and 50.8 cm (20.0") in length.



Figure 11 Lateral view of the front seat area showing the relative seat adjustment location and front right air bag excursion

The 7 year old female, who was 132.1 cm (52.0") tall and weighed 27.2 kg (60.0 lb.), was sitting on the leading edge of the seat cushion in front of her mother at the time of the crash. The child apparently had been sitting on the floor immediately forward of the front right seat for a long period of time prior to the crash. Her mother indicated that she had requested some refreshment and was allowed to relocate to the forward area of the seat cushion moments before the crash. The distance between the leading edge of seat cushion and the toe pan measured 41.9 cm (16.5") and 57.2 cm (22.5") to the engine wall.

The front restraint belts were a manual three point continuous loop lap and torso belt (**Figure 12**). The front left adjustable D-ring was in the full down position while the front right was located 2.5 cm (1.0") above full down over a 10.2 cm (4.0") vertical adjustment range. Both front belts exhibited heavy usage with score type witness marks on the latch plates (**Figure 13**). Both the driver and adult front right occupant indicated that they were wearing the restraint belts at the time of the crash. There was no visible evidence on the front restraint system related to usage during the crash. Given the low severity of the crash, the lack of crash related loading evidence was considered within normal expectations.



Figure 12 View of the front right continuous loop lap and torso restraint belt



Figure 13 View of usage related score marks on the front right restraint belt latch plate

The rear seat area was equipped with lap and torso belts in the outboard seat positions and a single lap belt in the rear center. The driver and front right occupant indicated that three of the children were using the restraint while the fourth child seated in the rear center left was unrestrained. Inspection of the belt system indicated that the center lap belt was tucked behind the seat back support and not available at the time of the crash (**Figure 14**). The latch plates on the outboard restraint belts exhibited score marks which were related to frequent belt usage. There was no visible evidence of crash related occupant contact points to the rear surfaces of the front seat back supports.



Figure 14 View of the rear seat area of the Chrysler showing the availability of the outboard lap and torso belts and the non availability of the center lap restraint belt

1995 Hyundai Elantra GLS - Exterior

The 1995 Hyundai Elantra GLS was struck along the rear plane by the front of the Chrysler Concorde which resulted in minor damage to the right rear area. Direct contact to the rear bumper measured 71.1 cm (28.0") wide which began 1.9 cm (0.75") left of the vehicle centerline and extended to the right bumper corner. The maximum crush of 12.7 cm (5.0") was located at the right rear bumper corner. Crush values are listed in the following table:

1995 Hyundai Elantra GLS - Crush Profile			
Impact with the 1995 Hyundai	$C_1 = 2.5 \text{ cm (1.0")}$	$C_2 = 1.4 \text{ cm (0.5")}$	$C_3 = 3.0 \text{ cm (1.2")}$
	$C_4 = 4.6 \text{ cm (1.8")}$	$C_5 = 5.8 \text{ cm (2.3")}$	$C_6 = 12.7 \text{ cm (5.0")}$

Collision Deformation Classification (CDC)

The collision deformation classification (CDC) code for the rear impact was assigned as follows: 06-BZEW-1.

SPEED RECONSTRUCTION

The WinSMASH speed reconstruction algorithm was used to compute relative delta V values. The output from the damage routine using the full width impact configuration indicated that the Chrysler experienced a total delta V of 10.1 km/h (6.3 mph) and the Hyundai sustained a 14.4 km/h (8.9 mph) as shown in the following table. The offset option of the WinSMASH program was also utilized with yielded results that were lower; 7.7 km/h (4.8 mph) for the Chrysler and 11.1 km/h (6.9 mph) for the Hyundai. Both computed values

appeared representative of the vehicle damage and were indicative that the SRS actuation was below the anticipated deployment threshold.

WinSMASH Speed Reconstruction Algorithm	1996 Chrysler Concorde LX	1995 Hyundai Elantra GLS
Total delta V	10.1 km/h (6.3 mph)	14.4 km/h (8.9 mph)
Longitudinal delta V	-10.1 km/h (-6.3 mph)	14.4 km/h (8.9 mph)
Lateral delta V	0 km/h	0 km/h
Energy dissipated	8,314 joules (6,137 ft-lb)	10,039 joules (7,411 ft-lb)
Barrier equivalent speed	10.5 km/h (6.5 mph)	13.9 km/h (8.6 mph)

SUPPLEMENTAL RESTRAINT SYSTEM (SRS)

The supplemental restraint system (SRS) comprised of dual front air bags which deployed during the crash. The threshold for deployment appeared to be lower than anticipated as the maximum longitudinal delta V computed by the WinSMASH program was 10.1 km/h (6.3 mph).

Front Left Air Bag

The front left driver module cover opened in the usual symmetrical “H” configuration pattern (**Figure 15**). The flaps measured 16.5 cm (6.5") laterally with a vertical dimension of 7.0 cm (2.75") for the top flap and 5.7 cm (2.25") for the bottom flap. The 1.9 mm (3/16") thick soft vinyl flaps did not exhibit any driver contact evidence.

The air bag measured 64.1 cm (25.25") in diameter with a 15.9 cm (6.25") stitched center tether attachment circle (**Figure 16**). The air bag contained two tethers in the 3 and 9 o'clock positions and did not have any visible vent ports. The front surface of the air bag was made of a fine gray mesh heavy denier nylon fabric while the rear surface was made of a white mesh with a lighter weight denier. There was no visible driver contact evidence noted on the surface of the air bag. The air bag identification number was located on a tag which was stitched into the rear surface of the air bag which read as follows:

PUT 12324-01C
TBN 6051A1346



Figure 15 View of the front left instrument panel and air bag module cover



Figure 16 View of the front left air bag

Front Right Air Bag

The front right air bag module cover was a top mount design which was hinged along the windshield seam edge. The cover was designed with a step up profile (**Figure 17**) where the leading edge was located 4.4 cm (1.75") below the top surface and had a step width of 3.8 cm (1.5"). The overall longitudinal length of the cover measured 17.5 cm (6.9") and was recessed 6.4 cm (2.5") from the vertical plane of the instrument panel (**Figure 18**) and 35.6 cm (14.0") from the base of the windshield. The lateral width of the cover measured 34.9 cm (13.9") along the leading edge and 36.2 cm (14.25") along the hinge edge. The cover appeared to be composed of a 15.9 mm (5/8") thick pliable vinyl material. There were no obvious occupant contact evidence on the cover.



Figure 17 View of the front right air bag module cover (artifacts shown in the photograph along the leading edge were related to post crash activities)



Figure 18 Lateral view of the right instrument panel highlighting the location of the front right air bag module cover to the leading edge of the instrument panel

The air bag had a single full width tether and lacked visible vent ports. The width of the air bag measured 55.9 cm (22.0") and had a static longitudinal excursion (**Figure 19**) of 40.6 (16.0") with a vertical height of 58.4 cm (23.0"). The front surface of the air bag exhibited a heavy concentration of bodily tissue which was concentrated in a 10.2 cm (4.0") wide band that extended 48.3 cm (19.0") in length. The tissue

artifact field began 24.1 cm (9.5") from the instrument panel and 12.7 cm (5.0") inboard from the right side of the air bag.



Figure 19 View of the front right air bag showing the relationship between the air bag excursion and the leading edge of the seat cushion



Figure 20 View of the bodily artifact tissue field located 12.7 cm (5.0") inboard from the right seam line

The pattern and length of the tissue transfer field indicated that the child was within close proximity to the air bag module cover at the time of the air bag deployment sequence. This transfer correlated with the medically described abrasion of the left anterior neck area.

INJURY DATA

There were seven people in the Chrysler at the time of the crash as identified in the following table:

Seat Position	Age (years)	Sex	Height	Weight	Restrained
Driver	37	Male	157.5 cm (62.0")	74.8 kg (165.0 lb.)	Lap and torso belt
Front Right Adult	27	Female	152.4 cm (60.0")	78.5 kg (173.0 lb.)	Lap and torso belt
Front Right Child	7	Female	132.1 cm (52.0")	27.2 kg (60.0 lb.)	Not restrained (no restraint belt available)
Rear Left	11	Male	144.8 cm (57.0")	41.3 kg (91.0 lb.)	Lap and Torso belt
Rear Left Center	10	Female	146.1 cm (57.5")	40.8 kg (90.0 lb.)	Not restrained

Rear Right Center	9	Male	132.1 cm (52.0")	31.8 kg (70.0 lb.)	Not restrained
Rear Right	14	Male	144.8 cm (57.0")	41.3 kg (91.0 lb.)	Lap and torso belt

The driver and the four children located in the rear seat area were not injured in the crash. The adult front right occupant suffered facial injuries and her 7 year old daughter seated in front of her sustained neck injuries. The child came to rest in the arms of her mother and remained there until rescue arrived approximately 6 minutes later. Rescue was unable to detect a pulse or respiration and assessed her Glasgow Coma Scale (GCS) as a 3. The child was rapidly removed from the vehicle and transported via ambulance to a local medical treatment facility where she arrived 22 minutes after the crash and was subsequently pronounced deceased 23 minutes later.

The child suffered a complete fracture separation of C1 from the base of the skull with complete spinal cord transection (AIS-6). This injury was determined by the coroner after analyzing x-ray film and noting the wide gap between C1 and C2 (**Figures 21 & 22**).



Figure 21 Right lateral x-ray view of the girl's neck and head showing the complete separation of C1 from base of the skull

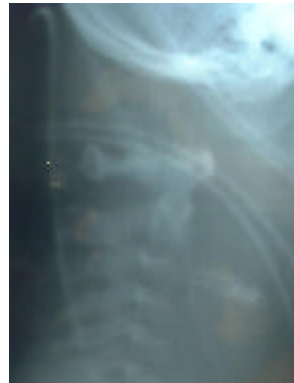


Figure 22 Close-up view of the atlanto-occipital fracture dislocation

The mother was transported to the same medical facility where she was treated and released. She subsequently sought follow-up treatment at two other medical treatment facilities over a two week period of time for two fractures of the left "cheek" bone, nerve damage along the left side of her face, a blood clot adjacent to the left eye, and impaired vision of the left eye.

The following tables list the injuries suffered by the child and mother as described in medical reports and during an interview.

INJURY 7 Year Old Female Front Right Occupant	AIS-90	INJURY SOURCE	
		Component	Certainty
1. Abrasion of the left anterior neck area	390202.1,2	Front right air bag	Certain

INJURY 7 Year Old Female Front Right Occupant	AIS-90	INJURY SOURCE	
		Component	Certainty
2. Bilateral contusion of the neck	390402.1,5	Front right air bag	Certain
3. Complete separation fracture of C1 from the base of the skull (visual examination of x-ray indicated probable complete cord transection)	640276.6,6	Front right air bag	Certain
4. Abrasion of the chin	290202.1,8	Front right air bag	Certain

Official medical records for the front right occupant indicated that a CT scan was taken of the facial bones, however, outcomes were not made available for this report. The injuries listed in the following table were described during an interview.

INJURY 27 Year Old Female Front Right Occupant	AIS-90	INJURY SOURCE	
		Component	Certainty
1. Fracture of the left cheek bone	250400.1,2	Child's head	Certain
2. Impaired vision of left eye	240499.1,2	Child's head	Certain
3. Left facial nerve injury	130299.2,9	Child's head	Certain
4. Cervical neck strain	640278.1,6	Child's head	Certain
5. Chest wall tender	Not a codeable injury	Child's torso	Certain
6. Abrasions of the jaws	290202.1,1 290202.1,2	Front right air bag	Probable

The driver and the two occupants in the Hyundai were not injured in the crash.

OCCUPANT KINEMATICS

1996 Chrysler Concorde LX

The driver was en route inland away from a potentially life threatening weather event and was in heavy traffic (stop and go) for approximately two hours prior to the crash. The driver indicated that the commute time from his residence to the area of the crash site was normally 30 minutes. As the driver approached a four leg intersection, a police officer who was standing in the center of the intersection waved the driver through the intersection. The driver remembered looking to his left at the police officer for what he described as a momentary glance. When he returned his attention back to his travel path, he noted that the vehicle in front of

him had stopped. The driver attempted to avoid the impending crash by applying full brakes and steering to the right.

The driver indicated that he was wearing the three point manual lap and torso restraint belts at the time of the crash. The lack of occupant contact evidence to interior components such as the steering wheel assembly, knee bolster, front left air bag module cover and air bag appears to be consistent with restraint belt usage.

Following the crash, the driver indicated that he removed his restraint belt and exited through his door. He then walked over to the police officer who was standing approximately 15 m (50') away to alert him of the crash and to request medical emergency services. He claimed the crash was so minor that the police officer was unaware of its occurrence.

The 7 year old female occupant was sitting on the forward portion of the front right seat cushion between the legs of her mother which placed her in close proximity to the instrument panel and air bag module cover prior to the crash sequence. From the abrasion pattern that was concentrated along the anterior left lateral aspect of child's neck and chin, it was theorized that her head was facing forward and slightly to the right.

During the pre-impact braking avoidance maneuver, the child's upper torso moved even closer to the instrument panel. However, from the lack of physical contact evidence along the surfaces of the air bag module cover, it appeared that the child's upper torso did not contact the module cover at the time of the SRS actuation sequence.

As the expanding air bag rotated the air bag module cover in an upward direction, the leading edge of the air bag simultaneously contacted the left anterior aspect of the child's neck and chin resulting in soft tissue abrasions. The air bag continued to expand and unfold against the child's neck/chin area which resulted in a continuous heavy tissue transfer observed on the top and vertical surfaces of the air bag. The child's head was then forced upward and rearward by the expanding air bag in a hyperextensive motion which resulted in complete fracture separation of C1 from the base of the skull with complete transection of the spinal cord. Her upper torso was then propelled a short distance rearward by the expanding air bag where her head struck the left facial area and chest of her mother.

The child came to rest in the mother's arms where the mother held onto her until rescue arrive 6 minutes after the crash. Upon arrival, rescue did not detect a pulse or respiration and assigned a Glasgow Coma Scale of 3. They expeditiously removed the child and transported her to the local medical treatment facility. The mother was removed from the vehicle by rescue, placed on a backboard and transported to the same medical treatment facility where she was treated and released.

The unrestrained children in the rear center seat positions moved forward and probably contacted the front seat back supports even though there was no visual contact evidence noted to the seat back supports. The restrained children in the outboard seating positions more than likely loaded the three point manual lap and torso restraint belts even though there was no visual evidence of occupant belt loading.