

On-Site Passenger Air Bag Child Fatality Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS03016
2001 Kia Spectra
California
April, 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 crash-worthiness performance of the involved vehicle(s) or their safety systems.

1. Report No. DS03016		2. Government Accession No.		3. Recipient Catalog No.	
4. Title and Subtitle Passenger Air Bag Child Fatality Investigation				5. Report Date	
				6. Performing Organization Report No.	
7. Author(s) Dynamic Science, Inc.				8. Performing Organization Report No.	
9. Performing Organization name and Address Dynamic Science, Inc. 530 College Parkway, Ste. K Annapolis, MD 21401				10. Work Unit No. (TRAIS)	
				11. Contract or Grant no. DTNH22-01-C-27002	
12. Sponsoring Agency Name and Address U.S. Dept. of Transportation (NRD-32) National Highway Traffic Safety Administration 400 7th Street, SW Washington, DC 20590				13. Type of report and period Covered [Report Month, Year]	
				14. Sponsoring Agency Code	
15. Supplemental Notes					
16. Abstract This on-scene Passenger Air Bag Child Fatality crash occurred in April 2003 at 1653 hours in the state of California. The case vehicle was a 2001 Kia Spectra GSX five-door hatchback driven by a restrained 30-year-old female. A 14-month-old female seated in a forward facing high back booster seat occupied the front right seat. The child seat had been placed in a fabric covered bucket seat that was adjusted to a point near the rear most track position. A restrained 57-year-old female occupied the rear left seat. A restrained 69-year-old male occupied the rear right seat. The other vehicle was a 1997 Ford Crown Victoria four-sedan driven by a 55- year-old male. The vehicle was being used as a taxi. The case vehicle was traveling southbound in the far right lane at a driver reported speed of 48 km/h (30 mph). The other vehicle was traveling northbound and had stopped to make a left hand turn to go west into a driveway. The driver stated that an unknown southbound vehicle had stopped and motioned for this driver to make the left hand turn. As the Crown Victoria turned and accelerated, it was struck in the right front by the front of the Kia Spectra. The case vehicle was pushed in a clockwise direction and came to rest facing southwest. The other vehicle was pushed sharply in a counterclockwise direction and came rest also facing southwest and nearly parallel with the case vehicle. All the adults in both vehicles were able to exit their respective vehicles on their own. There were no reports of any injuries to any of the adults in the crash. The front right occupant was fatally injured. She sustained a C2-C3 subluxation with a spinal cord injury that resulted in quadriplegia and ventilator dependency. There was extensive hemorrhaging in the paraesophageal area, as well as to the anterior cervical spine. She also sustained multiple superficial abrasions and contusions about the forehead, face, chin and anterior neck. She was given CPR on site and then transported to a local trauma center. She was pronounced dead at 1427 hours two days after being admitted.					
17. Key Words Air bag, deployment, injury, child seat, fatality, passenger,			18. Distribution Statement		
19. Security Classif. (of this report)		20. Security Classif. (of this page)		21. No of pages	22. Price

Dynamic Science, Inc.
Crash Investigation
Case Number: DS03016

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BACKGROUND:

Description: This Passenger Air Bag Child Fatality case was identified through a single news article. DSI was assigned the case on April 30, 2003. The case vehicle had been dismantled and partially repaired. The air bag modules had been removed. They had been replaced by non-functional modules. On-scene photographs were available and were obtained. Field work was completed on June 16, 2003.

Investigation Type: On scene, Passenger Air Bag Child Fatality Investigation

Crash Location: California

Crash Date: April, 2003

Notification Date: April 30, 2003

Field Work Completed: June 16, 2003

SUMMARY

Crash Site

This two-vehicle crash occurred in April 2003 at 1653 hours in the state of California. The crash occurred on a four-lane roadway within the confines of a driveway entrance. The roadway is a northbound/southbound city street consisting of one northbound lane, one southbound turn lane, and two southbound lanes. The weather was clear and dry. The asphalt roadway was level and dry. The speed limit for travel in both directions approaching the driveway was 40 km/h (25 mph). The driveway led into shopping center.



Figure 1. Approach to area of impact (south). Involved driveway to the right.

Pre-Crash

The case vehicle was a 2001 Kia Spectra GSX five-door hatchback driven by a restrained 30-year-old female (152 cm/60 in, 54 kg/120 lbs). The driver was seated in a fabric covered bucket seat that was adjusted to between the middle and rear most track position with a seat back angle of 72 degrees from horizontal. The vehicle was equipped with multistage driver's and front right passenger's air bags, 3-point front seat belts with adjustable shoulder anchors, front seat belt pretensioners with B pillar retractors, emergency locking retractor for the driver's seat belt, and switchable ALR/ELR retractors for the remaining outboard seat positions.

A 14-month-old female (79 cm/31 in, 14 kg/30 lbs) seated in a forward facing high back booster seat occupied the front right seat. The child seat had been placed in a fabric covered bucket seat that was adjusted to a point between the middle and forward most track position. The seat back angle was 68 degrees from horizontal. According to the driver, the child had been moved to the front seat because she was “being fussy and crying”. A restrained 57-year-old female occupied the rear left seat. A restrained 69-year-old male occupied the rear right seat.



Figure 2. Front, case vehicle

The case vehicle was traveling southbound in the far right lane at a driver reported speed of 48 km/h (30 mph). This contractor estimates the impact speed to be 32.0 km/h (19.89 mph)¹. The other vehicle was traveling northbound and had stopped to make a left hand turn to go west into the driveway. The driver stated that an unknown southbound vehicle had stopped and motioned for this driver to make the left hand turn.

Crash

As the Crown Victoria turned and accelerated, it was struck in the right front (03RFEW2) by the front of the Kia Spectra (12FDEW1)². The total velocity change calculated by the WinSmash collision model for the case vehicle was 19.0 km/h (11.8 mph). The longitudinal and lateral components were -18.7 km/h (-11.6mph) and 3.3 km/h (2.1 mph), respectively. This is a borderline reconstruction due to a lack of crush measurements.



Figure 3. Close up, front bumper of case vehicle

¹Calculated using conservation of linear momentum formula

²Calculated using CDCs from photos only. Case vehicle was torn down at the time of inspection.

Post-Crash

The case vehicle was pushed in a clockwise direction and came to rest facing southwest. The other vehicle was pushed sharply in a counterclockwise direction and came to rest also facing southwest and nearly parallel with the case vehicle.

The front right child occupant was removed from the vehicle by bystanders at the scene. She was not breathing. She was placed on ground and was being given CPR by a female witness until emergency personnel arrived. The front right occupant was fatally injured. She sustained a C2-C3 subluxation with a spinal cord injury that resulted in quadriplegia and ventilator dependency. There was extensive hemorrhaging in the paraesophageal area, as well as to the anterior cervical spine. She also sustained multiple superficial abrasions and contusions about the forehead, face, chin and anterior neck. She was given CPR on site and then transported to a local trauma center. She was pronounced dead at 1427 hours two days after being admitted.

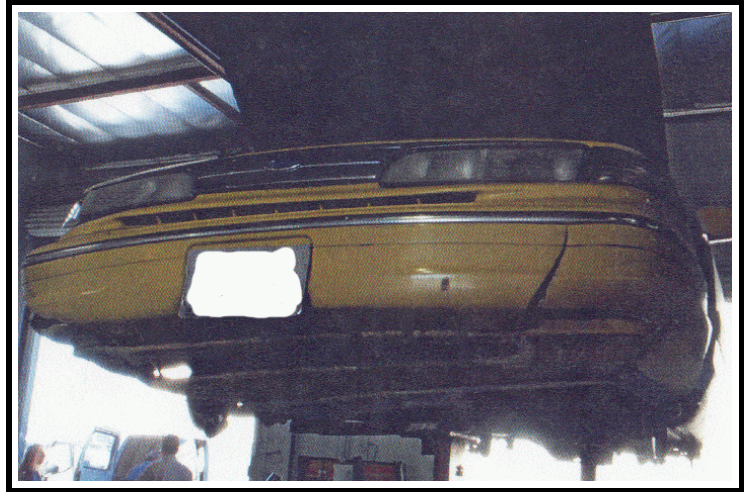


Figure 4. Front bumper of other vehicle (Crown Victoria)



Figure 5. Overview of driver and front right occupant seated positions, Kia Spectra (police photo)

SCENE DIAGRAM

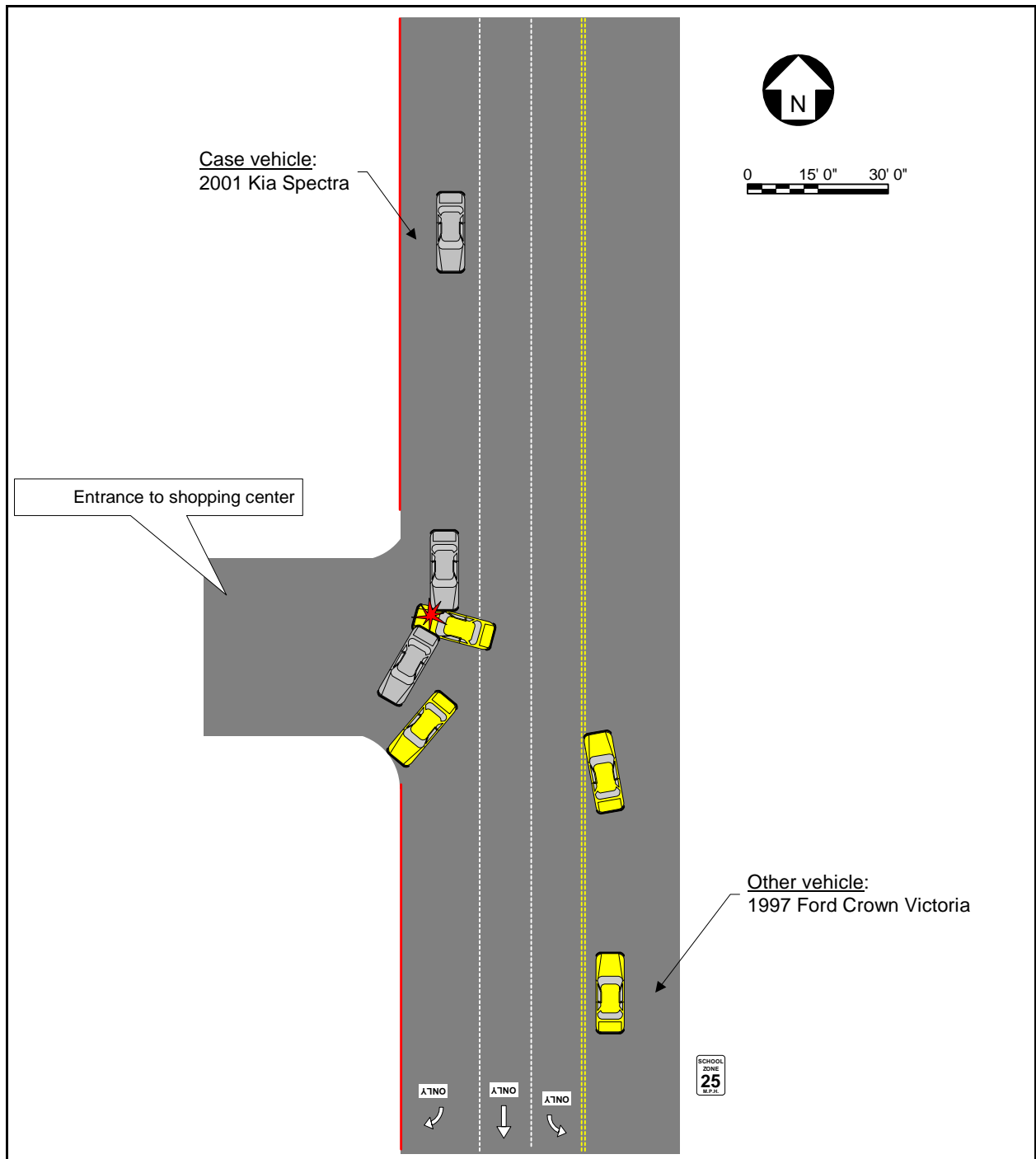


Figure 6. Scene diagram

VEHICLE DATA -2001 Kia Spectra GSX four door sedan

The Kia Spectra was a four-door sedan equipped with an automatic transmission and front wheel drive.

VIN: KNAFB1617150xxxxx
 Odometer: 30,926 km (19,217 km)
 Engine: 1.8 L/V4
 Reported Defects: Police inspected vehicle and did not find any significant mechanical deficiencies.
 Cargo: Child seat

The 2001 Kia Spectra was equipped with Hankook Radial H406 P185/65R14 tires. The specific tire data is as follows:

Tire	Tread	Pressure	Recommended pressure
LF	5 mm (0.19 in)	207 kPa (30 psi)	180 kPa (26 psi)
LR	5 mm (0.19 in)	179 kPa (26 psi)	180 kPa (26 psi)
RF	5 mm (0.19 in)	214 kPa (31 psi)	180 kPa (26 psi)
RR	3 mm (0.13 in)	179 kPa (26 psi)	180 kPa (26 psi)

The front seating positions in the 2001 Kia Spectra were configured with fabric covered bucket seats with adjustable head restraints. The left front seat was adjusted to between the forward most and middle track position. The right front seat was adjusted to the rear most track position at the time of inspection (police photos show the seat to be between the middle and forward most track position). Both seats were slightly reclined. The rear seating positions were configured with bench seats that were, by design, slightly reclined.

VEHICLE DAMAGE

Exterior Damage - 2001 Kia Spectra

Damage Description:	Moderate front end damage. Bumper, backing bar, hood, radiator.	
CDC:	12FDEW1	
Delta V:	Total	19.0 km/h (11.8 mph)
	Longitudinal	-18.7 km/h (-11.6 mph)
	Latitudinal	3.3 km/h (2.1 mph)
	Energy	27,164 joules (20,035 ft-lbs)

The case vehicle had been partially dismantled prior to inspection. The vehicle sustained 134.0 cm (52.7 in) of direct contact across the full width of the hood. The principle direction of force was within the 12 o'clock sector and was an estimated 350 degrees. The impact energy was managed by the forward structures of the vehicle. The damaged components for this impact included the bumper fascia and reinforcement bar, upper and lower radiator supports, and hood. There was damage to the right side of the windshield from the passenger air bag module cover.

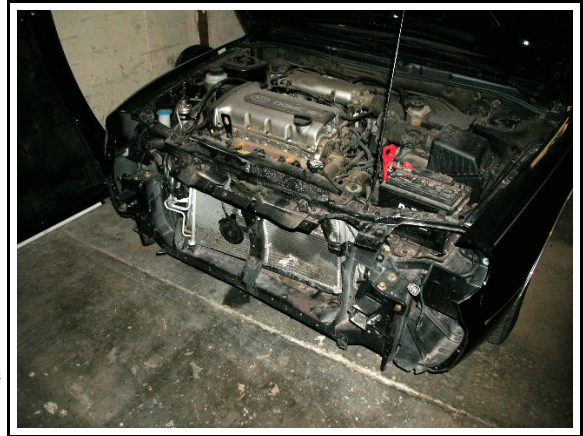


Figure 7. Front left, case vehicle

Interior Damage - 2001 Kia Spectra

Interior damage to the Kia Spectra was moderate and was attributed to the deployment of the various safety features. The windshield sustained fracture damage from the deploying front right air bag. The B-pillars were displaced by the seat belt pretensioners. There was loading damage to the two front seat belts. Both front air bags had been removed, but not replaced, prior to the vehicle inspection.

MANUAL RESTRAINT SYSTEMS - 2001 Kia Spectra

The Kia Spectra was configured with manual 3-point lap and shoulder belts with sliding latch plates for both front positions and the rear outboard positions. The front seat belts were equipped with B-pillar mounted pyrotechnic pretensioners. The right front seat and two rear outboard seats were equipped with switchable retractors. The driver's manual restraint was configured with an emergency locking retractor. Both front seat belts were in use at the time of the crash. The front right restraint was being used using with a child restraint at the time of the crash. The belt had been switched to the automatic locking mode. There were loading marks found on both the driver's and front right passenger seat belts. For the driver's belt, loading marks were located 21 cm (8.3 in) and 50 cm (19.7 in) from the stop button. For the front right passenger belt, loading marks were found 39 cm (36.6 in), 68 cm (26.8 in), and 145.0 cm (57.0) from the stop button. The pretensioners for both front seat belts actuated during the crash. The plastic covers for both B pillars were displaced by the pretensioned belts.



Figure 8. Loading marks to driver's seat belt

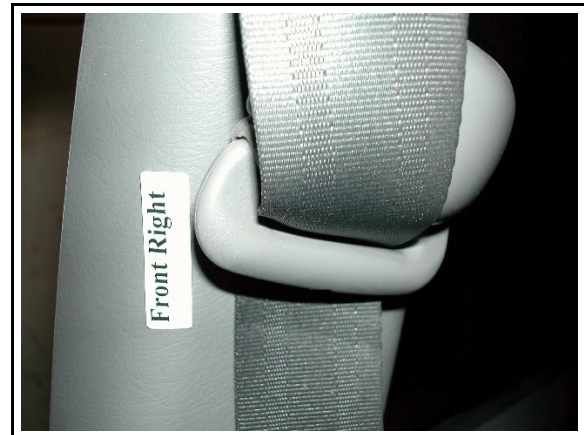


Figure 9. Loading marks to front right seat belt

FRONTAL AIR BAG SYSTEM - 2001 Kia Spectra

The driver and front right redesigned passenger air bags deployed and the front seat belt pretensioners actuated. The driver's air bag module had an "H" configuration and was located in the center hub of the steering wheel rim. The top flap measured 15 cm (5.9 in) wide and 12 cm (4.7 in) high. The bottom flap measured 15 cm (5.9 in) by 9 cm (1.9 in) high. The diameter of the air bag measured 54 cm (21.3 in) in its deflated state. There were two tethers and two vent ports. The ports were at the 11 and 1 o'clock positions.

The front right passenger's air bag was a top mount design located in the right aspect of the instrument panel. The module consisted of a single flap. The flap measured 33.0 cm (12.9 in) wide by 19.5 cm (7.7 in) high. The deflated air bag measured 33.0 cm (12.9 in) wide by 61 cm (24.1 in) high. There were no vent ports. There was a single tether across the face of the air bag. There were no indications of occupant contact. There was scuffing on the air bag face from the module cover.



Figure 10. Face of driver's air bag



Figure 11. Front right passenger's air bag, side view



Figure 12. Face of front right passenger's air bag

CHILD SAFETY SEAT - 2001 Kia Spectra

Cosco, “Eddie Bauer” high back booster seat, Model #02-880-MBP. It was manufactured on 06/06/2002. It was equipped with a 5-point internal harness system. The manufacturer recommends harness usage with children between 9.9-18.1 kg (22-40 lbs). When the child is heavier and the child’s shoulders are above the upper set of harness slots the seat is to be used as a belt-positioning booster for children between 13.6-36.2 kg (30-80 lbs). The vehicle seat belt was a 3-point lap and shoulder belt with a sliding latch plate and a switchable retractor. During the police inspection it was determined that the vehicle seat belt retractor was in the locked mode. The child seat was not anchored tightly in the vehicle and the seat could be moved several inches (see Figure 14). The harness straps were routed through upper slots. The straps were attached to a locking clip on the back side of seat instead of the splitter bar (see Figures 15-16). The locking clip was still stored in the factory storage location. Without the harness straps attached to the splitter bar, there was no way to adjust the harness system for snugness on the child occupant (Figure 17).



Figure 13. Exemplar view of Cosco Model #02-880-MBP child safety seat



Figure 14. Child seat movement (police photo)

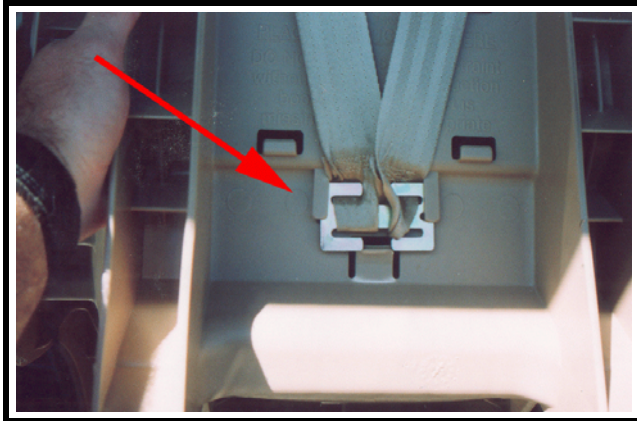


Figure 15. Back of child seat (harness attached to locking clip)

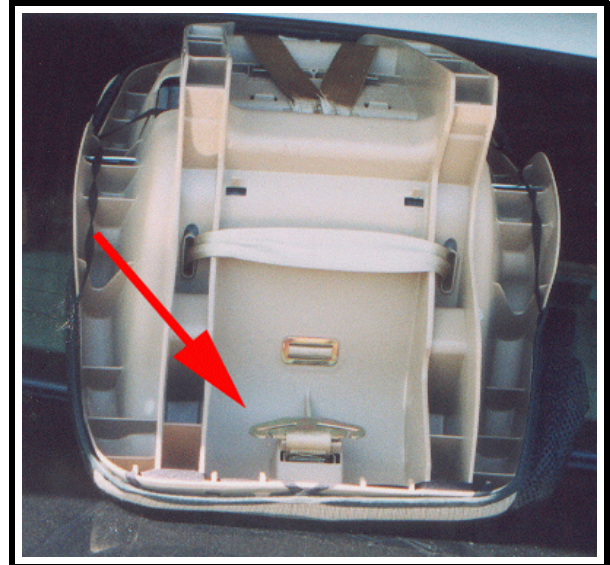


Figure 16. Bottom of child seat (actual attachment point for harness)

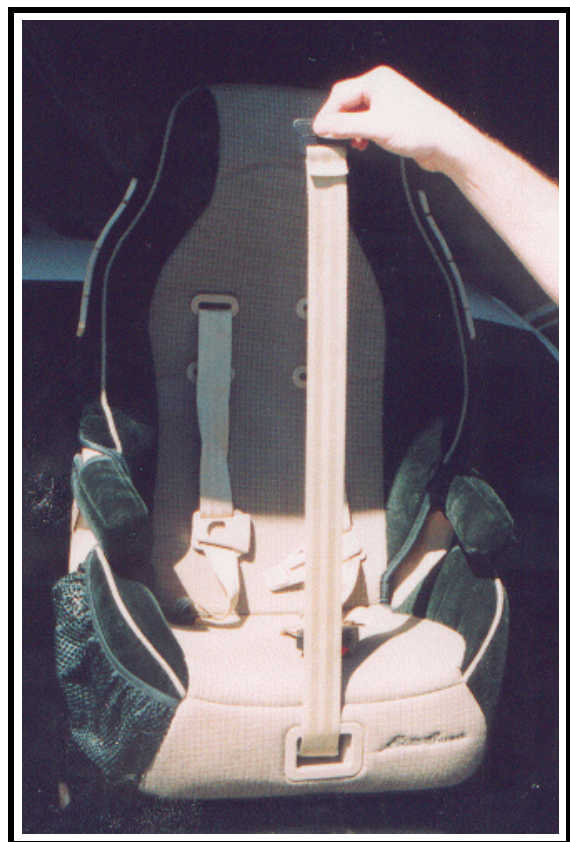


Figure 17. Front of child safety seat

VEHICLE DATA - 1997 Ford Crown Victoria four-door sedan

Description:	1997 Ford Crown Victoria four-door sedan	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	Police inspected vehicle and did not find any significant mechanical deficiencies.	
Cargo:	None	
Damage Description:	Moderate crush to right fender. Contact to right front wheel. Face of bumper fascia cracked.	
CDC:	03RFEW2	
Delta V:	Total	12.0 km/h (7.5 mph)
	Longitudinal	-2.1 km/h (-1.3 mph)
	Latitudinal	-11.8 km/h (-7.3 mph)
	Energy	11,036 joules (8.,140 ft lbs)



Figure 18. Right bumper corner



Figure 19. Right wheel/fender

OCCUPANT DEMOGRAPHICS - 2001 Kia Spectra

	Occupant 1	Occupant 2
Age/Sex:	30/Female	14 month/Female
Seated Position:	Front left	Front right
Seat Type:	Fabric covered bucket seat. Adjusted to between middle and rear most track position. Seat back angle of 72 degrees from horizontal.	Fabric covered bucket seat. Adjusted to between middle and forward most track position. Seat back angle of 68 degrees from horizontal.
Height:	152 cm (60 in)	79 cm (31 in)
Weight:	54 kg (120 lbs)	14 kg (30 lbs)
Occupation:	Unknown	None
Pre-existing Medical Condition:	None noted	None
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Normal, upright in child safety seat
Hand Position:	Unknown	Unknown
Foot Position:	Right foot presumed to be on accelerator, left on floor.	Unknown
Restraint Usage:	Lap and shoulder belt available, used. Pretensioner available, actuated.	Lap and shoulder belt available, used with child safety seat. Pretensioner available, actuated.
Air bag:	Steering wheel mounted air bag available, deployed	Top instrument panel mounted air bag, deployed

<u>Case vehicle</u>	Occupant 3	Occupant 4
Age/Sex:	57/Female	69/Male
Seated Position:	Rear left	Rear right
Seat Type:	Split bench with folding back.	Splint bench with folding back.
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	NA	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used

OCCUPANT DEMOGRAPHICS - other vehicleOther vehicle

Age/Sex:	55/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	170 cm (67 in)
Weight:	59 kg (130 lbs)
Occupation:	Driver
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be greater than 10 year
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Right presumed to be on accelerator, left on floor
Restraint Usage:	Lap and shoulder belt available, used per police

OCCUPANT INJURIES -2001 Kia Spectra

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Not injured			
Front right occupant:	C2-C3 subluxation with a spinal cord injury that resulted in quadriplegia and ventilator dependency. Hemorrhage, anterior cervical spine.	640220.5,6 ³	839.02 839.03 952.01	Air bag, flexion injury
	Abrasion over forehead, 7.6 x 5.0 cm (3.0 x 2.0 in)	290202.1,7	910.0	Air bag
	Abrasion, left supraorbital ridge	290202.1,2	910.0	Air bag
	Contusion, left upper eyelid	297402.1,2	921.1	Air bag
	Abrasion, left upper eyelid	297202.1,2	910.0	Air bag
	Abrasion, bridge of nose	290202.1,4	910.0	Air bag
	Abrasion, lower lip	290202.1,8	910.0	Air bag
	Abrasions (2), inferior aspect of chin	290202.1,8	910.0	Air bag
Rear left occupant:	Not injured			
Rear right occupant:	Not injured			

OCCUPANT INJURIES - other vehicle

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Not injured			

³Coded as complete cord syndrome NFS (quadraplegia or paraplegia with no sensation)

OCCUPANT KINEMATICS - 2001 Kia Spectra

The 30-year-old female (152 cm/60 in, 54 kg/120 lbs) driver of the case vehicle was seated in a normal, upright fashion. The fabric covered bucket seat was adjusted to between the middle and rear most track position. The leading edge of the seat cushion was 44.0 cm (17.3 in) rearward of the lower A pillar. The seat back was a 72 degree angle from horizontal. The driver was wearing the available lap and shoulder belt with an emergency locking retractor. The vehicle was equipped with retractor mounted seat belt pretensioners for the front seat belts. The seat belt anchorage was in the full up position. At impact, the driver's air bags deployed and seat belt front pretensioner actuated. The driver responded to the 12 o'clock direction of force by exhibiting a forward trajectory and loading the pretensioned lap and shoulder belt. The driver likely contacted the deployed air bag, but there were no indications of any contacts or damage. The driver did not report any injuries and was able to exit the vehicle on her own.

The 14-month-old female (79 cm/31 in, 14 kg/30 lbs) front right occupant was seated in a Cosco, "Eddie Bauer" high back booster seat, Model #02-880-MBP. The seat was equipped with a 5-point internal harness system. The harness was not attached to a fixed point on the child seat. The net effect of the attachment was that the harness was incapable of sustaining any load. The seat was anchored to the vehicle seat using the available lap and shoulder belt. However, the child seat was not tightly anchored to the vehicle seat. The fabric covered bucket seat was adjusted to a point between the middle and forward most track position. The leading edge of the seat cushion was 38.0 cm (14.9 in) rearward of the lower A pillar. The seat back was at a 68 degree angle from horizontal. The seat belt anchorage was in the full up position.



Figure 20. Driver's air bag



Figure 21. Loading to driver's seat belt

At impact, the front right passenger's air bag deployed and the seat belt pretensioners actuated. Though the pretensioner fired it does not appear that it was able to take in enough slack to anchor the child seat to the vehicle seat. As a result, the child seat pitched forward and the back end rose up to some unknown height. The front right occupant responded to the 12 o'clock direction of force by exhibiting a forward trajectory. As the child pitched forward she would not have been restrained to any significant degree by the child seat harness. She engaged the deploying air bag fully in the face. She sustained multiple superficial abrasions and contusions about the forehead, face, chin and anterior neck. Her head was forced backwards and she sustained a C2-C3 subluxation with a spinal cord injury that resulted in quadriplegia and ventilator dependency. There was also extensive hemorrhaging in the paraesophageal area, as well as to the anterior cervical spine. She was transported to an area hospital and died two days later.

The 57-year-old female rear left occupant was seated on a fabric covered split bench seat with a folding back. She was wearing the available lap and shoulder belt. The belt was equipped with a switchable retractor that was in emergency locking retractor mode. At impact, this occupant responded to the 12 o'clock direction of force by exhibiting a forward trajectory. There were no indications of loading to the seat belt. This occupant was not injured.

The 69-year-old male rear left occupant was seated on a fabric covered split bench seat with a folding back. He was wearing the available lap and shoulder belt. The belt was equipped with a switchable retractor that was in emergency locking retractor mode. At impact, this occupant responded to the 12 o'clock direction of force by exhibiting a forward trajectory. There were no indications of loading to the seat belt. This occupant was not injured.



Figure 22. Front right occupant seated position