On-Scene / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS97017
1997 Mercury Tracer LS
Arizona
July/1997

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be coupled with the investigator's expert knowledge and experience of vehicle dynamics and occupant kinematics in order to determine the pre-crash, crash, and post-crash movements of involved vehicles and occupants.

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

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
DS97017		

4. Title and Subtitle	5. Report Date
In-Depth Accident Investigation	November/1997
	6. Performing Organization Report No.

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

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

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

15. Supplemental Notes

16. Abstract

This collision occurred in July 1997 at 1822 hours. Vehicle 1, a 1997 Mercury Tracer LS four-door driven by a 22-year-old female, was traveling west approaching a four-leg intersection at 25-30 MPH. The driver was 8-1/2 months pregnant at the time of the crash. The right front of Vehicle 1 was occupied by a 5-year-old male. Both occupants were not using the available lap and shoulder belts. Vehicle 2, a 1994 Dodge Intrepid four-door driven by a 49-year-old male, was facing east and was in the left hand turn lane. As Vehicle 1 entered the intersection, Vehicle 2 began a left hand turn and then stopped. Vehicle 1 braked prior to impact, leaving 2.4 M (8 ft.) of locked wheel skids. The left front of Vehicle 1 struck the right front of Vehicle 2. The air bags in both vehicles deployed upon impact. Vehicle 1 came to rest in the intersection facing west. Vehicle 2 came to rest in the intersection facing northeast. The driver of Vehicle 1 indicated that after the crash she saw smoke and thought the vehicle was on fire. She stated that she unbuckled the child and removed him from the vehicle through the driver's door. In a statement attributed to her attorney, the driver indicated that the lap portion was properly placed but shoulder harness was placed beneath the left arm and across the chest of the child. There is no indication that the seat belt was used in any manner. This is based primarily on the location of the occupant's head at the time of deployment. It does not appear possible to reach this point while being restrained in any fashion. There is also no evidence of usage on the belt.

It appears that as the driver of Vehicle 1 braked, the child was pitched forward so that his head was between the module cover and the windshield. At deployment his head was lifted upwards and pushed into the windshield, fracturing his neck while cracking the windshield and deforming the module cover. After being removed from the vehicle, the child was then placed on the ground near the vehicle. An off-duty nurse began initial treatment at the scene, followed up by EMS personnel. The child was transported via air ambulance in critical condition with a broken neck. The driver of Vehicle 1 sustained airbag burns to her right and left anterior arms, as well as a bloody lip. She was transported via air ambulance to a local trauma center. According to police authorities, the driver is in good condition and the pregnancy has not been affected. The driver of Vehicle 2 sustained a bloody upper lip. He was transported to a local hospital where he was treated and released.

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, accident, fatal, child,	

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

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Dynamic Science, Inc.
Accident Investigation
Case Number: DS97017

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BACKGROUND:

Description:	This case was initiated in response to a report of a child-involved air bag fatality. Vehicle 1 was a 1997 Mercury Tracer LS driven by a 22-year-old female. The right front was occupied by a 5-year-old male.
Investigation Type:	On-Scene
Crash Location:	Arizona
Crash Date:	July 1997
Notification Date:	August 1, 1997
Field Work Completed:	August 4, 1997

SUMMARY:

This collision occurred in July 1997 at 1822 hours. Vehicle 1, a 1997 Mercury Tracer LS four-door driven by a 22-year-old female, was traveling west approaching a four-leg intersection at 40-48 km/h (25-30 MPH). The driver was 8-1/2 months pregnant at the time of the crash. The right front of Vehicle 1 was occupied by a 5-year-old male. Both occupants were not using the available lap and shoulder belts. Vehicle 2, a 1994 Dodge Intrepid four-door driven by a 49-year-old male, was facing east and was in the left hand turn lane.

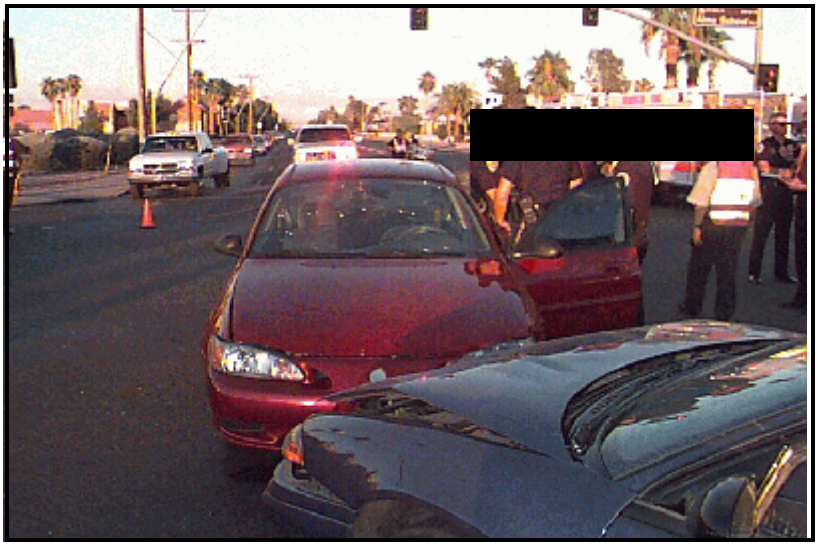

Figure 1. Final rest, looking east.

As Vehicle 1 entered the intersection, Vehicle 2 began a left hand turn and then stopped. Vehicle 1 braked prior to impact, leaving 2.4 M (8 ft.) of locked wheel skids. The left front of Vehicle 1 struck the right front of Vehicle 2. The air bags in both vehicles deployed upon impact. Vehicle 1 came to rest in the intersection facing west. Vehicle 2 came to rest in the intersection facing northeast. Vehicle 1 sustained a computed delta V of 10.3 km/h (5.5 MPH). These results are low; the bumper had restituted almost completely.

The driver of Vehicle 1 indicated that after the crash she saw smoke and thought the vehicle was on fire. She stated that she unbuckled the child and removed him from the vehicle through the driver's door. In a statement attributed to her attorney, the driver indicated that the lap portion was properly

placed but shoulder harness was placed beneath the left arm and across the chest of the child. There is no indication that the seat belt was used in any manner. This is based primarily on the location of the occupant's head at the time of deployment. It does not appear possible to reach this point while being restrained in any fashion. There is also no evidence of usage on the belt.

It appears that as the driver of Vehicle 1 braked, the child was pitched forward so that his head was between the module cover and the windshield. At deployment the module cover struck the underside of his chin and he was lifted upwards and pushed into the windshield, fracturing his neck while cracking the windshield and deforming the module cover. According to the autopsy report, he sustained a fracture-dislocation of the upper cervical spine, a fracture of the odontoid process of C2, and a partial transection of the medulla and upper cervical spinal cord. In addition, this occupant sustained abrasions to the chin, along the edge of the right chin, beneath the chin, to the right side of the neck, and to the ulnar surface of the left forearm.

Figure 2. Final rest, facing southwest.

Immediately post-crash, the driver of Vehicle 1 opened her door and pulled the child out of the vehicle by the arms. She held the child in her arms while standing for a short time, then went to her knees. According to witness information it was apparent that the child's head was in an unnatural position and there was no movement. The child was then placed on the ground near the vehicle. An off-duty nurse began initial treatment at the scene, followed up by EMS personnel. The child was transported via air ambulance in critical condition with a broken neck. According to the medical examiner, he survived for approximately 36 hours prior to pronouncement of death.

The driver of Vehicle 1 sustained airbag burns to her right and left anterior arms, as well as a bloody lip. She was transported via air ambulance to a local trauma center. According to police authorities, the driver was in good condition and the pregnancy had not been affected. The driver of Vehicle 2 sustained a bloody upper lip. He was transported to a local hospital where he was treated and released.

SCENE DIAGRAM

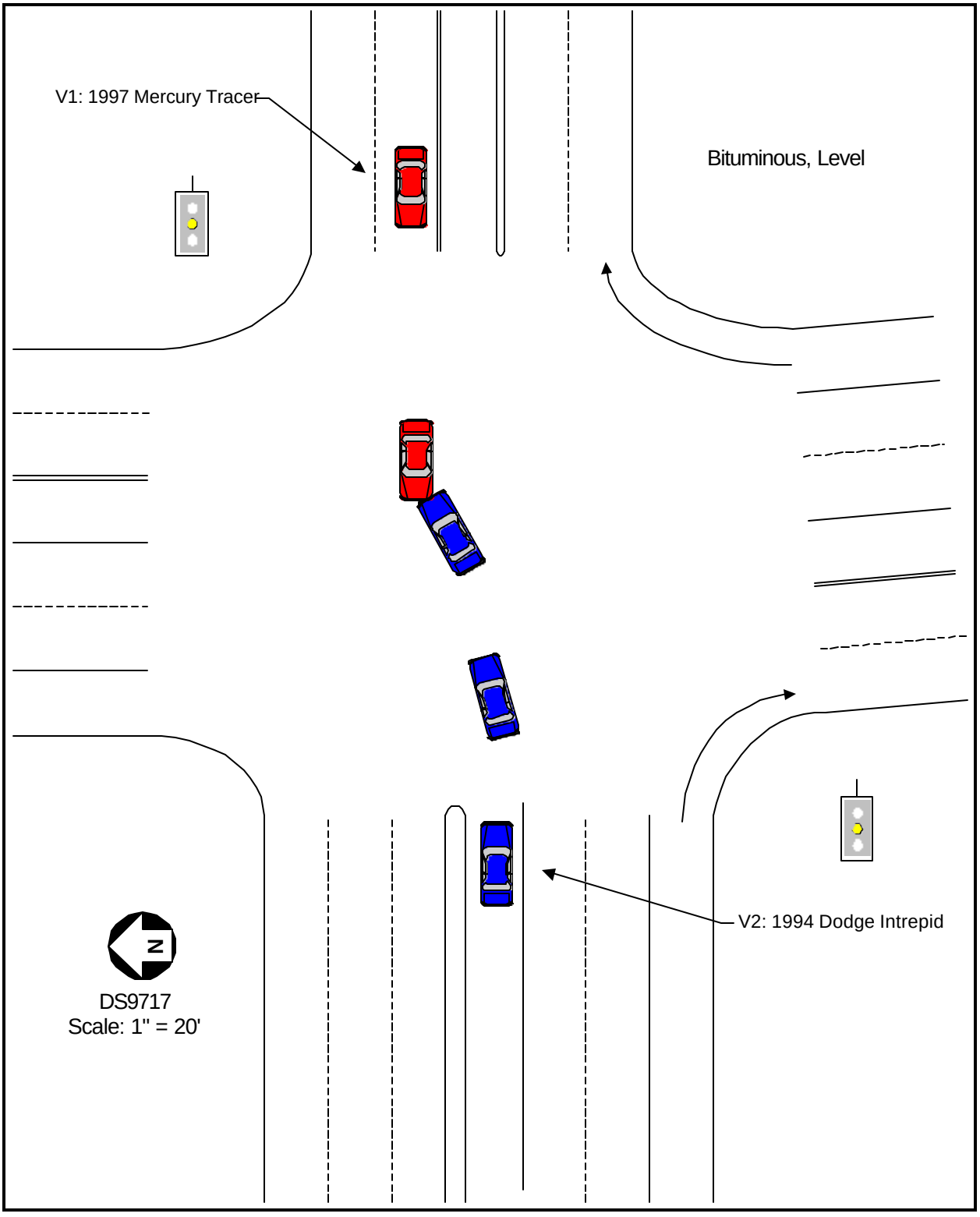

Figure 3. Scene diagram

DETAILED INFORMATION

Vehicles

Vehicle 1

Description:	1997 Mercury Tracer LS	
VIN:	1MELM13P2VWxxxxxx	
Odometer:	34,869 km (21,667 miles)	
Engine:	2.0 L I 4	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Light scratches to left front bumper corner, slight rearward deformation. Near complete restitution.	
CDC:	12FLLW1	
Minimum Travel Speed[1]:	23 km/h (14 MPH)	
Delta V[2]:	Total	10.3 km/h (5.5 MPH)
	Longitudinal	-10.3 km/h (-5.5 MPH)
	Latitudinal	00 km/h (00 MPH)
	Energy	6082 joules (4486 ft-lbs)

[1]

Simple Speed from Skid
Skid Distance = 8 feet
Coefficent of Friction = .7
Braking Efficency = 1.00
S = Sqr(30 * D * f * n)
S = 12.96

Combined Speed Formula
Sc = Sqr($S1^2+S2^2+S3^2+S4^2$)
Sc = 14.08

[2]Calculated using WinSmash program. Results are low. Bumper had restituted almost completely.

This vehicle is equipped with bucket seats in the front and a bench seat in the rear. The left front seat was in the mid position, while the right front was in the position aft of the mid position. Both seats were slightly reclined. The driver's side airbag was 68 cm (26.7 in.) in diameter and was mounted in a 38 cm (15 in.) steering wheel. It had a single tether and two vents. The module consists of an igniter assembly, inflator, mounting plate and retainer ring, the bag assembly and the liner and steering wheel trim cover. The passenger side airbag measures 45 cm (17.7 in.) wide by 69 cm (27.2 in.) high and was enclosed in a mid-mount module. The module cover measured 30 cm (1.8 in.) wide by 19 cm (7.5 in.) high. The module consists of an igniter assembly, inflator, and reaction housing. The airbag had no tethers and two vents. It had a maximum excursion of 74 cm (29.1 in.). Both air bags are constructed of a neoprene coated nylon. Neither airbag sustained any damage. There was no intrusion. The right rear window disintegrated due to contact with an interior object–most likely the driver's side head restraint. It is unclear if this occurred during the crash or during rescue efforts. The damage occurred from the inside to the outside of the vehicle. The vehicle is equipped with a 5 MPH bumper comprised of a polycarbonate beam and a TPO fascia.

Figure 4. Exterior, Vehicle 1.

Figure 5. Exterior, Vehicle 1.

Figure 6. Exterior, Vehicle 1. Closeup of bumper.

Vehicle 2

Description:	1994 Dodge Intrepid 4-door	
VIN:	1B3HD46T8RFxxxxxx	
Odometer:	Unknown	
Engine:	3.6 L V-6	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Minor scrapes to right front bumper, slight rearward displacement of bumper, hood slightly buckled.	
CDC:	01FRLW1	
Minimum Travel Speed:	Stopped	
Delta V:	Total	7.2 km/h (3.8 MPH)
	Longitudinal	-6.6 km/h (-3.5 MPH)
	Latitudinal	-3.1 km/h (-1.6 MPH)
	Energy	4335 joules (3199 ft-lbs)

This vehicle is equipped with bucket seats in the front and a bench seat in the rear. Both seats were slightly reclined. The driver's side airbag was mounted in the steering wheel. The passenger side airbag was enclosed in a top-mount module. Neither airbag appears to have sustained any damage. There was no intrusion nor any integrity loss to the interior of the vehicle.

Figure 7. Exterior, Vehicle 2.

Figure 8. Exterior, Vehicle 2.

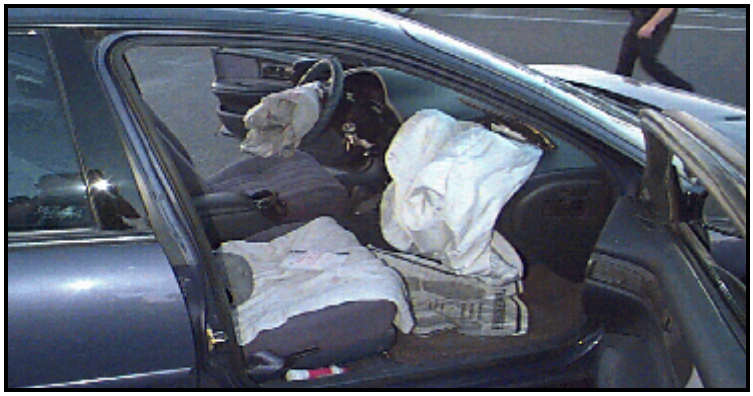

Figure 9. Interior, Vehicle 2

Occupants

Vehicle 1	Occupant 1	Occupant 2
Age/Sex:	22/Female	5/Male
Seated Position:	Left front	Right front
Seat Type:	Bucket	Bucket
Height:	Unknown	112 cm (44 in.)
Weight:	Unknown	19 kg (42 lbs.)
Occupation:	Unknown	NA
Pre-existing Medical Condition:	8-1/2 months pregnant	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Presumably < 10 years	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, position not known	Unknown
Foot Position:	Right foot presumed to be on brake pedal.	Unknown
Restraint Usage:	None used	None used
Air bag:	Driver's side air bag deployed	Passenger side air bag deployed

Vehicle 2	Occupant 1	
Age/Sex:	49/Male	
Seated Position:	Left front	
Seat Type:	Bucket	
Height:	Unknown	
Weight:	Unknown	
Occupation:	Dry wall installer	
Pre-existing Medical Condition:	Unknown	
Alcohol/Drug Involvement:	None	
Driving Experience:	> 20 years	
Body Posture:	Unknown	
Hand Position:	Unknown	
Foot Position:	Right foot on brake	
Restraint Usage:	Lap only, per police report	
Air bag:	Driver's side air bag deployed	Passenger side air bag deployed

Injuries and Injury Mechanisms

Vehicle 1

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Abrasion, left forearm	790202.1,2	913.0	Airbag
	Abrasion, right forearm	790202.1,1	913.0	Airbag
	Lip injury	290099.1,8	959.0	Airbag
Right front occupant				
	Fracture/dislocation cervical spine with partial cord transection	640260.5,6	806.04	Module cover
	Abrasion, left forearm	790202.1,2	913.0	Unknown
	Contusion/abrasion base of left index finger on dorsum of the hand	790202.1,2 790402.1,2	915.0 923.20	Unknown
	Deep abrasion, right chin	290202.1,8	910.0	Module cover
	Abrasion, right chin	290202.1,1	910.0	Module cover
	Abrasion, right chin	290202.1,1	910.0	Module cover
	Linear abrasion, right lateral neck	390303.1,1	910.0	Airbag
	Curving abrasion, up to 3 inches in length-extends from the midline of the right of the chin	3903202.1,5	910.0	Module cover
	Linear ½ x 2 inch abrasion beneath chin	390202.1,5	910.0	Module cover
	Linear, horizontal laceration, 3/4 inch, beneath chin	290602.1,8	873.44	Module cover

Vehicle 2

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Unknown lip injury	290099.1,8	959.0	Unknown

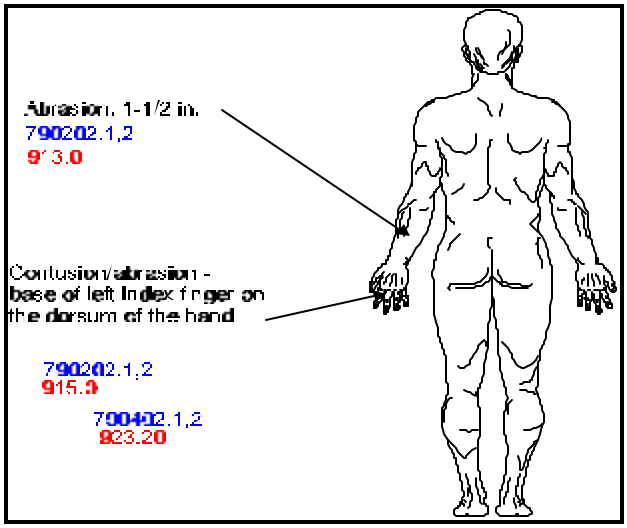

Figure 10. Occupant 2, Vehicle 1, extremity injuries

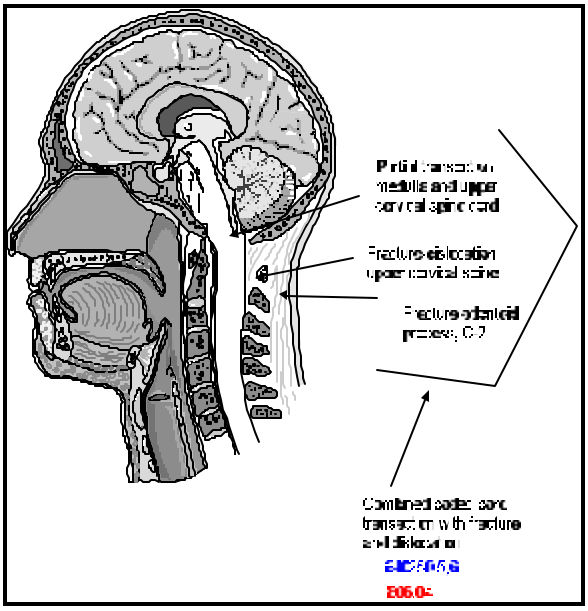

Figure 11. Occupant 2, Vehicle 1, spinal injury

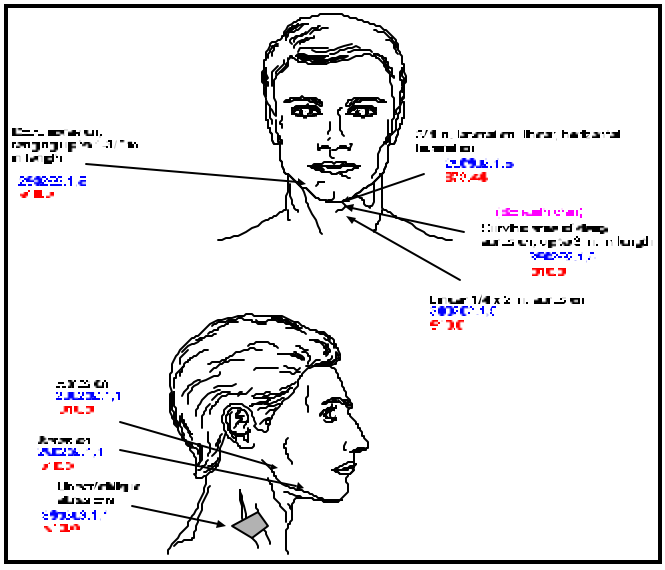

Figure 12. Occupant 2, Vehicle 1, facial abrasions/lacerations

Occupant Kinematics

The 5-year-old male occupant was seated in the right front bucket seat, facing forward. The seatback was tilted slightly backwards and was situated 80 cm (31 in.) from the face of the instrument panel. This occupant was not wearing the available lap and shoulder belt. It appears that as the driver of Vehicle 1 braked, the child was pitched forward so that his head was between the module cover and the windshield. At deployment the module cover struck the underside of his chin and he was lifted upwards and pushed into the windshield, fracturing his neck while cracking the windshield and deforming the module cover. A skin transfer was deposited on the face of the module cover. According to the autopsy report, he sustained a fracture-dislocation of the upper cervical spine, a fracture of the odontoid process of C2, and a partial transection of the medulla and upper cervical spinal cord. In addition, this occupant sustained abrasions to the chin, along the edge of the right chin, beneath the chin, to the right side of the neck, and to the ulnar surface of the left forearm.

Figure 13. Windshield contact, exterior view

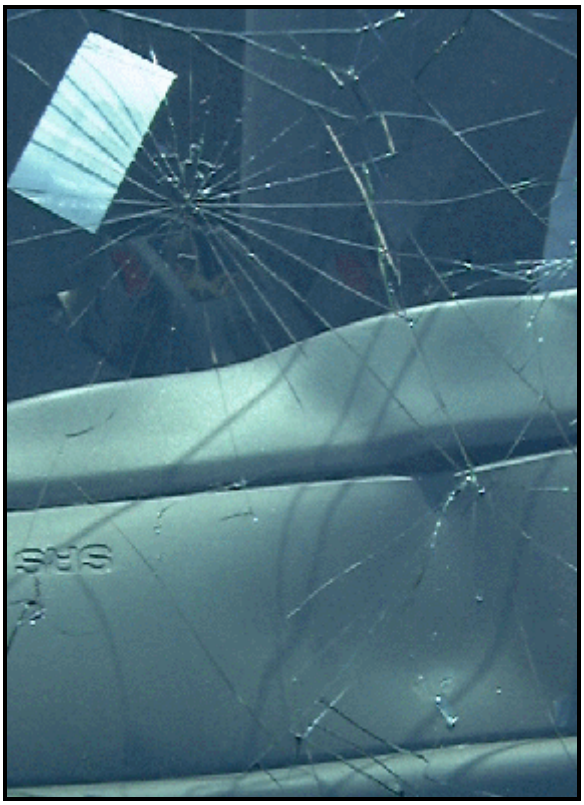

Figure 14. Windshield contact, exterior view, close-up

Figure 15. Module cover

Figure 16. Deformed module cover

Figure 17. Vehicle Interior

Photo Index

Photo no.	Vehicle No.	Direction of Picture	Subject Matter
DS97017-1 - DS97017-3	1	West	Approach to area of impact.
DS97017-4	1	West	Area of impact.
DS97017-5 - DS97017-6	2	East	Approach to area of impact.
DS97017-7	2	East	Area of impact.
DS97017-8	2	West	Looking back along vehicle travel path.
DS97017-9 - DS97017-31	1	CCW	Exterior of vehicle.
DS97017-32 - DS97017-62	1	NA	Interior of vehicle.

Selected Police Photo Index

Photo no.	Vehicle No.	Direction of Picture	Subject Matter
DS97017P01 - DS97017P05	1 / 2	NA	Final rest.
DS97017P06 - DS97017P09	1	NA	Interior views.
DS97017P10 - DS97017P11	2	NA	Exterior views.
DS97017P12 - DS97017P13	2	NA	Interior views.
DS97017P14 - DS97017P17	1 / 2	NA	Close up views of exterior damage.