

On-Scene / Vehicle to Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS97013
1995 Hyundai Accent
Utah
June/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.

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16. Abstract This case is being conducted as an on-scene investigation. This collision occurred in Utah on June, 1997 at 1712 hours. Vehicle 1, a 1995 Hyundai Accent 3-door hatchback driven by a restrained 31-year-old female, was traveling north and stopped at an intersection. The speed limit for this roadway is 40 km/h (25 mph). The right front seat was occupied by a 3-month-old female (63.1 cm / 25 in - . 8 kg/17 lbs). She was in a supine position in a rearward facing child restraint. The mother indicated that the lap/shoulder belts were used to anchor the child restraint to the vehicle seat. The child was restrained using the child restraint's 3-point shoulder harness. Vehicle 2, a 1981 Cadillac El Dorado 2-door driven by a non-restrained 26-year-old male, was traveling westbound approaching the intersection and decelerating to turn right and head north at a driver stated 32 km/h (20 mph). The driver indicated that it was raining hard and his wipers were on. There were three additional occupants in Vehicle 2. The right front seat was occupied by a non-restrained 6-year-old male. The second left seat was occupied by a non-restrained 23-year-old female. The second right seat was occupied by a non-restrained 3-year-old male. Vehicle 3, a 1994 Chevrolet 3/4 ton K25 4-WD pickup driven by a restrained 22-year-old male, was traveling south and stopped at the intersection. The driver of Vehicle 1 indicated that she looked but did not see any vehicles, and started across the intersection. The driver of Vehicle 2 saw Vehicle 3 pull up to the intersection, he then turned to look to his left and saw Vehicle 1 crossing in front of his vehicle. As the driver applied the brakes, the front of Vehicle 2 (11FYEW1) struck the right side of Vehicle 1 (02RYEW3). There was a second side-slap impact between the right rear of Vehicle 1, and the left side of Vehicle 2. Vehicle 1 was then redirected counterclockwise and traveled north-west. The left front of Vehicle 1 (12FYEW1) struck the left front of Vehicle 3 (11FYLW1). Vehicle 1 sustained a longitudinal Delta-V of -19.2 km/h (-11.9 MPH) in the collision with Vehicle 3, causing both air bags in Vehicle 1 to deploy. Vehicle 1 sustained major damage and was towed from the scene due to damage. Vehicle 2 sustained major damage to its front end and was towed from the scene under orders of the police. Vehicle 3 sustained minor damage and was driven from the scene. When the vehicles came to final rest, the driver of Vehicle 1 smelled and saw "foggy smoke" inside the vehicle. The driver of Vehicle 3 then assisted in the aid of the child in Vehicle 1. Paramedics arrived six minutes after the collision occurred and the child was in full cardiac arrest with no vital signs, and CPR was initiated. Paramedics then took the child to a local hospital where they arrived at 1730 hours. Glasgow coma score was three on arrival, and with CPR the child was able to regain electrical activity of her heart. Emergency records indicate that the child had obvious deformities in her occipital skull, and there was blood and gray brain matter coming out of her ears. It was decided to move her to a different hospital and at 1836 hours a helicopter life flight was dispatched. The life flight arrived at the first hospital at 1902 hours and departed at 1938 hours. They arrived at the second hospital at 1953 hours. CPR was continued and after vigorous attempts at resuscitation, the child was pronounced dead at 2015 hours. No autopsy was performed, but an ultrasound was performed twenty minutes after discontinuing CPR. The ultrasound indicated an extensive 6 mm diastatic right parietal and occipital skull fractures with marked extracranial soft tissue swelling and evidence of increased intracranial pressure indicating a severe closed head injury. The skull fractures were caused by the air bag striking the back of the child restraint and the seat back of the child restraint then striking the back and right side of the child's head.					
17. Key Words Air bag, deployment, injury, collision, child, fatal			18. Distribution Statement		
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Dynamic Science, Inc.
Accident Investigation
Case Number: DS97013

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BACKGROUND:

Description:	This case was initiated in response to a report of an air bag related fatal injury to a child. The 3 month-old-child was restrained in a rearward facing child restraint in the right front seat.
Investigation Type:	On-Scene
Crash Location:	Utah
Crash Date:	June, 1997
Notification Date:	June, 1997
Field Work Completed:	June, 1997

SUMMARY:

This three vehicle collision occurred during the early evening hours of a summer weekday at the intersection of a divided roadway. It was raining and the roadway was wet, but free of defects. At the area of impact the north-south asphalt roadway is a two-way, two lane, straight and level, divided roadway. The east-west asphalt roadway is a two-way, straight and level, divided roadway. North and south traffic is controlled by stop signs at the intersection.

Vehicle 1, a 1995 Hyundai Accent 3-door hatchback driven by a restrained 31-year-old female, was traveling north and stopped at an intersection. The speed limit for this roadway is 40 km/h (25 mph). The right front seat was occupied by a 3-month-old female (63.1 cm / 25 in¹ - . 8 kg/17 lbs). She was in a supine position in a rearward facing child restraint. The mother indicated that the lap/shoulder belts were used to anchor the child restraint to the vehicle seat. The child was restrained using the child restraint's 3-point shoulder harness.

Vehicle 2, a 1981 Cadillac El Dorado 2-door driven by a non-restrained 26-year-old male, was traveling westbound approaching the intersection and decelerating to turn right and head north at a driver stated 32 km/h (20 mph). The driver indicated that it was raining hard and his wipers were on. There were three additional occupants in Vehicle 2. The right front seat was occupied by a non-restrained 6-year-old male. The second left seat was occupied by a non-restrained 23-year-old female. The second right seat was occupied by a non-restrained 3-year-old male.

Vehicle 3, a 1994 Chevrolet 3/4 ton K25 4-WD pickup driven by a restrained 22-year-old male, was traveling south and stopped at the intersection.

¹ "Anthropometry of Infants, Children, and Youths to Age 18 for Product Safety Design", SAE SP-450.

The driver of Vehicle 1 indicated that she looked but did not see any vehicles, and started across the intersection. The driver of Vehicle 2 saw Vehicle 3 pull up to the intersection, he then turned to look to his left and saw Vehicle 1 crossing in front of his vehicle. As the driver applied the brakes, the front of Vehicle 2 (11FYEW1) struck the right side of Vehicle 1 (02RYEW3). There was a second side-slap impact between the right rear of Vehicle 1, and the left side of Vehicle 2. Vehicle 1 was then redirected counterclockwise and traveled north-west. The left front of Vehicle 1 (12FYEW1) struck the left front of Vehicle 3 (11FYLW1). Vehicle 1 sustained a longitudinal Delta-V of -19.2 km/h (-11.9 MPH) in the collision with Vehicle 3, causing both air bags in Vehicle 1 to deploy. Vehicle 1 sustained major damage and was towed from the scene due to damage. Vehicle 2 sustained major damage to its front end and was towed from the scene under orders of the police. Vehicle 3 sustained minor damage and was driven from the scene.

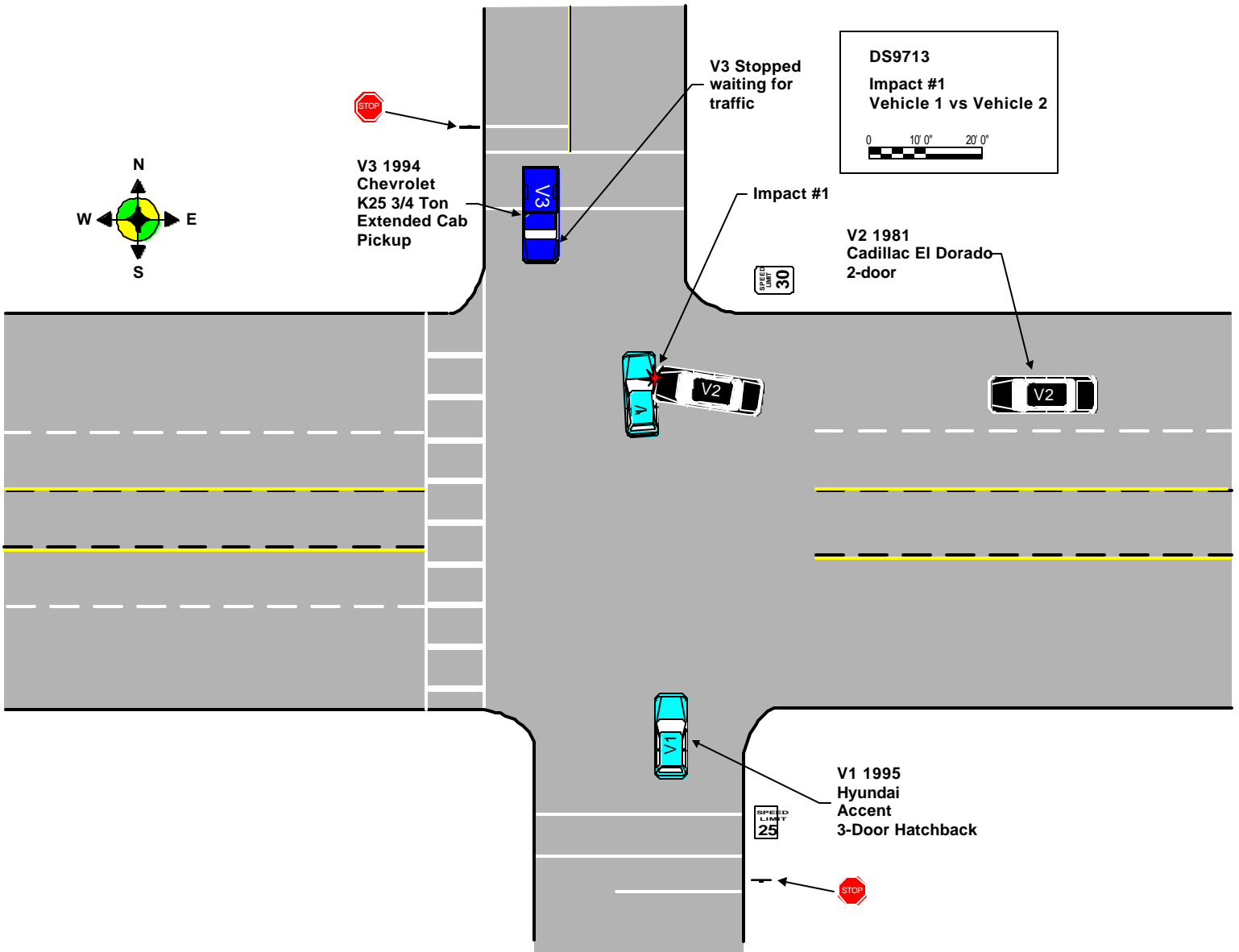
When the vehicles came to final rest, the driver of Vehicle 1 “smelled and saw foggy smoke” inside the vehicle. The driver of Vehicle 3 then assisted in the aid of the child in Vehicle 1. Paramedics arrived six minutes after the collision occurred and the child was in full cardiac arrest with no vital signs, and CPR was initiated. Paramedics then took the child to a local hospital where they arrived at 1730 hours. Glasgow coma score was three on arrival, and with CPR the child was able to regain electrical activity of her heart. Emergency records indicate that the child had obvious deformities in her occipital skull, and there was blood and gray brain matter coming out of her ears. It was decided to move her to a different hospital and at 1836 hours a helicopter life flight was dispatched. The life flight arrived at the first hospital at 1902 hours and departed at 1938 hours. They arrived at the second hospital at 1953 hours. CPR was continued and after vigorous attempts at resuscitation, the child was pronounced dead at 2015 hours. No autopsy was performed, but an ultrasound was performed twenty minutes after discontinuing CPR. The ultrasound indicated an extensive 6 mm diastatic right parietal and occipital skull fractures with marked extracranial soft tissue swelling and evidence of increased intracranial pressure indicating a severe closed head injury. The skull fractures were caused by the air bag striking the back of the child restraint and the seat back of the child restraint then striking the back and right side of the child’s head.

The police took photographs of injuries sustained by the driver of Vehicle 1 (see photos 31-33). She sustained injuries consisting of a laceration over her right eyebrow that required four stitches. Numerous small lacerations to the entire right side of the face that were caused by flying glass and the driver’s air bag. She had an abrasion and contusion to the upper inside of her right arm caused by the air bag. Small lacerations to her right forearm were caused by flying glass. A contusion to her upper left shoulder area was caused by the shoulder belt. She was transported via ambulance to a local hospital where she was treated in the ER and then was released.

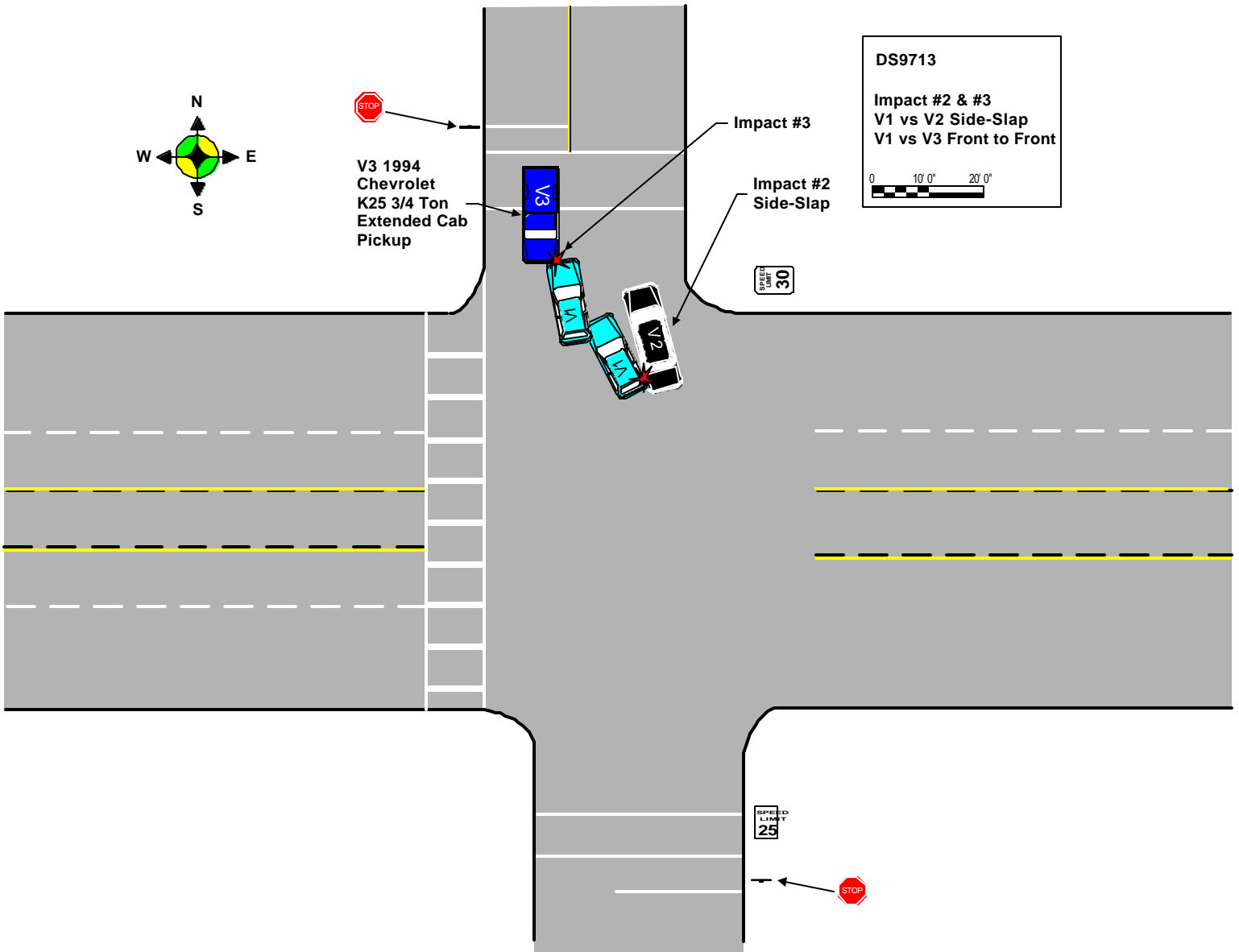
The right front occupant in Vehicle 2 sustained a possible injury to his face from contact with the instrument panel. None of the other occupants were injured.

The driver of Vehicle 3 was not injured.

SCENE DIAGRAM - page 1



SCENE DIAGRAM - page 2



DETAILED INFORMATION

Vehicles

Vehicle 1

Description: 1995 Hyundai Accent 3-door hatchback
 VIN: KMHVD14N9SU01XXXX
 Odometer: 122,875 km (76,353 miles)
 Engine: 1495 cc OHC L4
 Reported Defects: None
 Cargo: None visible
 Damage Description: Major damage to the right side. Minor damage to the right rear, and moderate damage to the front bumper, primarily on the left side with an override of the hood.
 CDC Impact # 1 Vehicle 1 vs Vehicle 2: 02RYEW3



Impact Speed² : 24.5 km/h (15.2 MPH)

2

Speed after acceleration from a stop over a known distance

$$S = \sqrt{2aD}$$

S = speed after acceleration

a = acceleration rate (4 ft/sec/sec)

D = distance (62 ft)

$$S = \sqrt{2 \cdot 4 \cdot 62}$$

$$S = 22.28 \text{ fps}$$

$$S = 22.28 / 1.467$$

$$S = 15.2 \text{ mph} / 24.5 \text{ km/h}$$

Delta V ³ :	Total	23.0 km/h (14.3 MPH)
	Longitudinal	-7.9 km/h (-4.9 MPH)
	Latitudinal	-21.6 km/h (-13.4 MPH)
	Energy	14,676 joules (10,834 ft-lbs)

CDC Impact # 3 Vehicle 1 vs Vehicle 3: 12FYEW1



Impact Speed:	Unknown	
Delta V ⁴ :	Total	19.5 km/h (12.1 MPH)
	Longitudinal	-19.2 km/h (-11.9 MPH)
	Latitudinal	3.4 km/h (2.1 MPH)
	Energy	12,099 joules (8,927 ft-lbs)

Vehicle 1 is equipped with dual bucket seats in the front and a bench seat in the rear. At the time of inspection the left front seat was adjusted to the most forward position. The right front seat could not be accurately measured due to the intrusion of the door panel and the sill, but it was visually inspected and it was approximately adjusted the same distance as the left front seat. The driver's seat back was fully reclined and this may have been done by paramedics in order to treat the child. The right front seat back was slightly reclined. The driver's side

³ Damage only algorithm of WinSmash.

⁴ Damage only algorithm of WinSmash.

air bag had two tethers and two vents. The passenger side air bag was enclosed in a mid-mount module. The module cover opens rearward toward the windshield in a hinged fashion, and on deployment cracked the windshield. The module cover was deformed, and it is believed that this is due to the child restraint contacting the cover at the moment of deployment. The air bag had a single tether across the face of the air bag, and two vents. The driver's air bag did not sustain any damage. The right front air bag sustained two punched type holes, the cause of this is not known. There were also several cuts on the right side of the bag that appear to have been caused by contact with the child restraint. The entire top front portion of the air bag had bluish transfer/smudging (see photos # 115-118), caused by contact with child restraint seat padding. The right front door intruded into the right front passenger compartment and contacted the child restraint, there is white transfer/smudging on the door panel and the door handle was knocked off (see photos #105-106). The right and left side glass had both been shattered. The right front side glass was shattered due to the impact with Vehicle 2. The left side glass was shattered due to contact with the driver's head.

Vehicle 2

Description: 1981 Cadillac El Dorado 2-door

VIN: AZ88XXX (VIN has been replaced, apparently due to the vehicle being stolen).

Odometer: 187,213 km (116,332 miles)

Engine: V8

Reported Defects: None noted

Cargo: None visible

Damage Description: Major damage across the front bumper. Minor damage to the left side. Vehicle was driveable and impounded by the police.

CDC: 11FYEW1



Impact Speed:	Unknown	
Delta V ⁵ :	Total	12.6 km/h (7.8 MPH)
	Longitudinal	-11.8 km/h (-7.3 MPH)
	Latitudinal	4.3 km/h (2.7 MPH)
	Energy	21,186 joules (15,632 ft-lbs)

⁵ Damage only algorithm of WinSmash.

Vehicle 3

Description: 1994 Chevrolet K25 3/4 ton Pickup 4WD Extended Cab

VIN: 2GCFK29K8R111XXXX

Odometer: Unknown

Engine: V8 5.7L TBI

Reported Defects: None

Cargo: None

Damage Description: Minor damage to the front bumper, primarily on the left corner. The chain hook had been torn off and embedded in the bumper of Vehicle 1.

CDC: 11FYLW1



Impact Speed: 0.0 km/h (0.0 MPH), stopped waiting at the stop sign

Delta V⁶ :

Total	9.1 km/h (5.7 MPH)
Longitudinal	-8.6 km/h (-5.3 MPH)
Latitudinal	3.1 km/h (1.9 MPH)
Energy	10,368 joules (7,651 ft-lbs)

⁶ Damage only algorithm of WinSmash.

Occupants

<u>Vehicle 1</u>	Occupant 1	Occupant 2
Age/Sex:	31/Female	3 months / Female
Seated Position:	Left front	Right front
Seat Type:	Bucket, with folding back	Bucket, with folding back
Height:	Unknown	. 63.1 cm (24.8 in), crown-sole length ⁷
Weight:	Unknown	. 8 kg (17 lbs)
Additional Measurement⁸ :		
Crown-sole length:		63.1 cm (24.8 in)
Crown-rump length:		42.3 cm (16.7 in)
Shoulder breadth:		18.7 cm (7.4 in)
Shoulder-elbow length:		12.3 cm (4.8 in)
Head circumference:		41.7 cm (16.4 in)
Head breadth:		11.4 cm (4.5 in)
Head length:		14.6 cm (5.7 in)
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Lying supine in a rearward facing infant child seat
Hand Position:	Both on steering wheel	Unknown
Foot Position:	Left on floor, right on accelerator	Unknown
Restraint Usage:	Lap and shoulder used	Lap and shoulder belt in conjunction with the child seat
	Driver's side air bag deployed	Front right air bag deployed

⁷ "Anthropometry of Infants, Children, and Youths to Age 18 for Product Safety Design", SAE SP-450

⁸ "Anthropometry of Infants, Children, and Youths to Age 18 for Product Safety Design", SAE SP-450

<u>Vehicle 2</u>	Occupant 1	Occupant 2	Occupant 3
Age/Sex:	26/Male	6/Male	23/Female
Seated Position:	Left front	Right front	Second left
Seat Type:	Split Bench with folding backs	Split Bench with folding backs	Bench
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	Unknown	Unknown
Occupation:	Unknown	NA	Unknown
Pre-existing Medical Condition:	Unknown	Unknown	Unknown
Alcohol/Drug Involvement:	None	NA	NA
Driving Experience:	Unknown	NA	NA
Body Posture:	Normal, Upright	Unknown	Unknown
Hand Position:	Presumably on steering wheel	NA	NA
Foot Position:	Presumably the left on floor, right on brake	NA	NA
Restraint Usage:	None used	None used	None used

<u>Vehicle 2 (Cont.)</u>	Occupant 4
Age/Sex:	3/Male
Seated Position:	Second right
Seat Type:	Bench
Height:	Unknown
Weight:	Unknown
Occupation:	NA
Pre-existing Medical Condition:	Unknown
Alcohol/Drug Involvement:	NA
Driving Experience:	NA
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	None used

<u>Vehicle 3</u>	Occupant 1
Age/Sex:	22/Male
Seated Position:	Left front
Seat Type:	Bucket with folding back
Height:	. 170 cm (67 in)
Weight:	. 64 kg (140 lb)
Occupation:	Unknown
Pre-existing Medical Condition:	None
Alcohol/Drug Involvement:	NA
Driving Experience:	6 years
Body Posture:	Normal, upright
Hand Position:	Presumably both on steering wheel
Foot Position:	Left on floor, right on brake
Restraint Usage:	Lap and shoulder belt used per PAR

Injuries and Injury Mechanisms

Vehicle 1

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Laceration right eyebrow, required four stitches	290602.1,7	873.42	Possibly air bag
	Numerous small lacerations to the entire right side of the face	290602.1,1	873.40	Flying glass
	Abrasion to upper inside of right arm	790202.1,1	913.0	Air bag
	Contusion to upper inside of right arm	790402.1,1	920.0	Air bag
	Small lacerations to right forearm	790602.1,1	881.00	Flying glass
	Contusion to upper left shoulder area	790402.1,2	923.10	Shoulder belt
RF Occupant	Horizontal skull fracture of the occipital bone approximately midway between posterior of foramen magnum and lambda. With loss of brain tissue	150206.4,8	801.45	Child restraint back/air bag
	Approximately 6 mm diastatic right parietal skull fracture extending from the lower coronal suture obliquely across right parietal bone to posterior sagittal suture with marked extracranial soft tissue swelling. The anterior superior portion of right parietal bone is displaced laterally. Cranial sutures mildly spread, evidence of increased intracranial pressure.	150404.3,1	800.45	Child restraint back/air bag
	Loss of consciousness	160824.5, 0	800.66	Child restraint back/air bag

Laceration to face	290600.1,9	873.40	Possibly air bag wrapping around child seat
Ecchymosis to face	290402.1,9	920.0	Possibly air bag wrapping around child seat
Contusions bilaterally to lower extremities (unknown exact extremity)	890402.1,9	920.0	Unknown

Injuries and Injury MechanismsVehicle 2

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Not injured			
Right front occupant:	Unknown injury to the face. PAR indicates possible injury.	215099.7,9	959.0	Instrument panel
Second left occupant:	Not injured			
Second right occupant:	Not injured			

Vehicle 3

	<u>INJURY</u>
Driver:	Not injured

Occupant Kinematics

The right front seat in Vehicle 1 was occupied by a 3-month-old female. She was in a supine position in a rearward facing Gerry Secure Ride Model 621, 625, 626 infant car seat. The mother indicated that she had purchased the child restraint at Sears and she had received instructions, but could not remember what. The owner's manual was still attached to the child restraint at the time of the inspection. The mother indicated that the vehicle lap/shoulder belts were used to restrain the child restraint to the vehicle seat. The lap/shoulder belts were pinned between the seat and the door side panel, and there were also load marks on the webbing. The child was restrained using the child restraint's 3-point shoulder harness. A locking clip was not used with the free sliding latch plate as it recommended in the owner's manual. The child restraint was positioned so that its top-back was approximately 2 cm (0.8 in) from the right front module cover (see photo # 127). It appears that the child may have been drinking from a bottle, so that her head was turned to the right.

On impact with Vehicle 2, the right side door panel intruded and struck the child restraint. There is white colored transfer on the right front door panel, and the door handle was broken off (see photo #106 & 108). This shifted the child restraint to the left and closer to the module cover.

At impact with Vehicle 3, the air bag module cover rotated upward and contacted the child restraint. There is no evidence of contact to the module cover, but this may be due to the padded child restraint cover. The air bag began to deploy and contacted the child restraint seat pad. The air bag has bluish transfer to the entire front (see photos 116-119). The air bag struck the child restraint's handle and broke it off. (see photos 129-131 and 133-134). The air bag also struck the back of the child restraint, and the seat back of the child restraint then struck the head of the child. The child sustained an extensive 6 mm diastatic right parietal and occipital skull fractures with marked extracranial soft tissue swelling and evidence of increased intracranial pressure indicating a severe closed head injury. There was bleeding, and gray-brain matter leaking from her ears.

Paramedics arrived six minutes after the collision occurred and the child was in full cardiac arrest with no vital signs, and CPR was initiated. Paramedics then took the child to a local hospital where they arrived at 1730 hours. Glasgow coma score was three on arrival, and with CPR the child was able to regain electrical activity of her heart. It was decided to move her to a different hospital and at 1836 hours a helicopter life flight was dispatched. The life flight arrived at the first hospital at 1902 hours and departed at 1938 hours. They arrived at the second hospital at 1953 hours. CPR was continued and after vigorous attempts at resuscitation, the child was pronounced dead at 2015 hours.



Figure 7. Position of child restraint at the scene.



Figure 8. Position of child restraint at the scene.

Photo Index

Photo no.	Vehicle No.	Direction of Picture	Subject Matter
The following photographs were taken by the police at the scene of the collision			
01-08	1 & 3	---	Final rest positions of both vehicles.
09-12	2	---	Final rest position, driven there after impact.
13-16	3	---	Damage to vehicle.
17-27	1	---	Damage to vehicle.
28-30	1	---	Interior of vehicle at scene showing position of child restraint, and position of air bag behind the child restraint.
31-33	---	---	Injuries to driver of Vehicle 1.
** The following photograph were taken by the investigator **			
34-36	1	North	Approach path to impact #1 with Vehicle 2.
37-38	1	North	Area of impact #1.
39-39	1	North-West	Post impact direction of travel, impact area with Vehicle 3, and final rest area.
40-41	1	South	Opposite direction of travel.
42	2	West	Approach path to impact #1 with Vehicle 1.
43	2	West	Impact area.
44-45	2	West/North	Area driven to after impact.
46	2	East	Opposite direction of travel.
47-48	3	South	Direction vehicle stopped, and area of impact #3 with Vehicle 1.
49	3	North	Opposite direction of travel.
50-78	1	—	Exterior damage to vehicle.

79-123 *83-84 *96 *97 *106-108 *116-123	1	---	Interior of vehicle. Driver's lap and shoulder belt. Left A-pillar blood spots. Sun Visor missing. Right front air bag. Right front air bag, note blue transfer.
124-128	1	---	Child restraint, presumed position at time of collision.
129-136	1	—	Child restraint and damage to handle.
137-138	1	—	Second seat.
139-156	2	—	Exterior damage to vehicle.
157-170	2	—	Interior of vehicle.
171-179	3	—	Exterior of vehicle.
180-186	3	—	Interior of vehicle.