On-Scene / Vehicle to Vehicle / Front to Right Side
Dynamic Science, Inc. / Case Number: DS98019
1997 Nissan Quest XE Minivan
Colorado
May, 1998

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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

The case vehicle was a 1997 Nissan Quest minivan driven by an unrestrained 28-year-old male (191 cm-75 in/125 kg-275 lbs) that was traveling eastbound at 56 km/h (35 mph) as estimated by the police. The driver of the case vehicle had picked up several children from school. They were on their way home and were less than a mile from the school. There were four additional occupants in the case vehicle. The front right seat was occupied by an unrestrained 3-year-old male ((20 kg-45 lbs). The second right seat position was occupied by a 1-year-old female in an unknown type child carrier; the direction the carrier was facing is also unknown. The infant was restrained inside the carrier, but the carrier was not anchored by the available lap/shoulder restraints to the vehicle seat. This was verified by one of the witnesses who removed the child from the vehicle after the crash. The third left seat position was occupied by an unrestrained 10-year-old male (40 kg-87 lbs). The third center seat position was occupied by an unrestrained 9-year-old female (38 kg-84 lbs). The other vehicle was a 1979 Datsun 280 ZX driven by a restrained 67-year-old male, and was traveling westbound and attempting a left turn into a residential driveway directly in front of the case vehicle.

When the 280 ZX turned left in front of the case vehicle, the driver of the case vehicle braked. The case vehicle deposited four wheels locked skidmarks on the roadway. The investigating police agency conducted "braking test" with a police vehicle which deposited four wheels locked skidmarks on top of the skidmarks left by the case vehicle. The case vehicle was unable to stop and its front (12FDEW1) broadsided the right side (02RYEW3) of the 280 ZX. On impact, both air bags in the case vehicle deployed. The damage and trajectory algorithm of WinSmash calculated a total delta v of 16.4 km/h (10.2 mph), a longitudinal delta v of -16.3 km/h (-10.2 mph), and a latitudinal delta v of -1.4 km/h (-0.9 mph) for the case vehicle. After impact, the case vehicle rotated slightly clockwise and came to final rest heading east. The 280 ZX was pushed counterclockwise and came to final rest heading south. The case vehicle sustained minor damage to its front end. The case vehicle was towed from the scene, but was driveable. The 280 ZX sustained major damage and intrusions to the right side and was towed from the scene.

The driver of the case vehicle believed that the front right occupant was seated in a normal upright position on the seat. The mother of the child indicated that the child was hard to control and did not like to keep the lap/shoulder restraints on. It is assumed by this investigator that the child was probably seated upright and in a forward facing position and was not wearing the available lap/shoulder restraints. Due to the pre-impact braking, he was pitched forward towards the top of the instrument panel. He appears to have stuck out his right and left arms. There are indications of contacts to the windshield by his right hand and his forehead. His head was probably rebounding from the windshield when the impact between the case vehicle and the 280 ZX occurred. The windshield was struck by the air bag, there is evidence of fiber imprint onto the glazing. As the front right passenger's air bag deployed the module cover probably contacted the left side of the front right occupant's face causing an avulsion (AIS 1) which extended from the left corner of his mouth to the left preauricular area. The air bag contacted the front right occupant about his entire face causing numerous abrasions (AIS1). The air bag also contacted his right arm and shoulder areas causing numerous abrasions (AIS1). His right arm appears to have then been flung towards the right A-pillar, shattering the plastic covering around the A-pillar. As the front passenger's air bag continued its unfolding sequence it contacted the front of the child's neck and underneath his chin–causing a multiple abrasions (AIS1)--and the front right occupant was lifted upwards. As the air bag fully deployed it "snapped" and accelerated the child's head rearward. This caused the fatal injuries consisting of a complete transection of the brainstem at the pontine-medullary junction (AIS5) with a complete posterior disarticulation of the base of the skull from the cervical spine at the atlanto-occipital joint (AIS2). He also sustained subarachnoid hemorrhaging (AIS3). The front right occupant was thrown backwards. The front right occupant came to rest on the right side of his face between the front left and second seats facing towards the rear of the vehicle.

17. Key Words	18. Distribution Statement
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Dynamic Science, Inc.
Accident Investigation
Case Number: DS98019

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BACKGROUND:

Description:	This case is being initiated in response to a report of fatal injuries to the front right occupant, a 3-year-old male, as a result of the deployment of the front right passenger's air bag. The case was conducted as an on-site investigation. The National Highway Traffic Safety Administration (NHTSA) was notified by the Regional NHTSA office as a result of a newspaper article. DSI was notified and assigned the case on May 5, 1998 at 1219 hours via fax.
Investigation Type:	On-Site, both involved vehicles were inspected.
Crash Location:	Colorado
Crash Date:	May, 1998
Notification Date:	May 5, 1998
Field Work Completed:	May 12, 1998

SUMMARY:

The crash occurred in the state of Colorado in May, 1998 at 1502 hours. At the point of impact, the roadway is an east-west, two-way, undivided, asphalt, straight residential street. The roadway has a negative slope for the case vehicle direction of travel. The weather was clear, the road was dry and clear of defects. There are no traffic controls present, and the posted speed limit is 40 km/h (25 mph).

Figure 1. Crash scene–heading east.

The case vehicle was a 1997 Nissan Quest minivan driven by an unrestrained 28-year-old male (191 cm-75 in/125 kg-275 lbs) that was traveling eastbound at 56 km/h (35 mph) as estimated by the police. The driver of the case vehicle had picked up several children from school. They were on their way home and were less than a mile from the school. There were four additional occupants in the case vehicle. The front right seat was occupied by an unrestrained 3-year-old male ((20 kg-45 lbs). The second right seat position was occupied by a 1-year-old female in an unknown type child carrier; the direction the carrier was facing is also unknown. The infant was restrained inside the carrier, but the carrier was not anchored by the available lap/shoulder restraints to the vehicle seat. This was verified by one of the witnesses who removed the child from the vehicle after the crash. The third left seat position was occupied by an unrestrained 10-year-old male (40 kg-87 lbs). The third center seat position was occupied by an unrestrained 9-year-old female (38 kg-84 lbs). Both of the occupants in the third seat indicated to the police at the scene that they were not wearing the lap/shoulder restraints; later when they were questioned by their parents they indicated

that they were wearing the lap/shoulder restraints and were confused and scared when questioned by police. The lap/shoulder restraints do indicate previous usage, but there is no evidence of usage at the time of the collision. The mother, who was not in the vehicle at the time of the collision, indicated that they were aware that the case vehicle was equipped with a driver's air bag and she was not sure that it had a front right passenger air bag. She was aware of air bags causing fatal injuries to children and that when she drove the case vehicle she did not allow any of the children to ride in the front right seat.

The other vehicle was a 1979 Datsun 280 ZX driven by a restrained 67-year-old male, and was traveling westbound and attempting a left turn into a residential driveway directly in front of the case vehicle.

When the 280 ZX turned left in front of the case vehicle, the driver of the case vehicle braked. The case vehicle deposited four wheels locked skidmarks on the roadway. The investigating police agency conducted a "braking test" with a police vehicle which deposited four wheels locked skidmarks on top of the skidmarks left by the case vehicle.

The case vehicle was unable to stop and its front (12FDEW1) broadsided the right side (02RYEW3) of the 280 ZX. On impact, both air bags in the case vehicle deployed. The damage and trajectory algorithm of WinSmash calculated a total delta v of 16.4 km/h (10.2 mph), a longitudinal delta v of -16.3 km/h (-10.2 mph), and a latitudinal delta v of 1.4 km/h (0.9 mph) for the case vehicle. The 280 ZX sustained a total delta v of 25.2 km/h (15.7 mph), a longitudinal delta v of -11.1 km/h (-6.9 mph), and a latitudinal delta v of -22.6 km/h (-14.1 mph). These results fit the collision model and appear reasonable for both vehicles.

Figure 2. Damage and final rest positions.

After impact, the case vehicle rotated slightly clockwise and came to final rest heading east. The 280 ZX was pushed counterclockwise and came to final rest heading south. The case vehicle sustained minor damage to its front end. The case vehicle was towed from the scene, but was driveable. The 280 ZX sustained major damage and intrusions to the right side and was towed from the scene.

The case vehicle is equipped with box mounted seats in the front and folding bench seats for the second and third seats. At the time of inspection the left front and right front seats were adjusted to the rear most track positions. Both seats were slightly reclined. The driver's side air bag had two tethers and two vents ports. The front right passenger's air bag was enclosed in a top-mount type module. The single module cover opens upwards toward the windshield in a hinged fashion. The air bag had one tether across the entire face of the air bag, and two vents ports. There was occupant contact evidence across the left upper area of the front right passenger's air bag. Neither air bag or module covers sustained any damage.

On impact, the driver of the case vehicle was struck in the face by the air bag, “knocked out” and lost his breath. This is presumed to mean that he was stunned for a few seconds. He exited the vehicle and ran around to the right side and rolled opened the right side sliding door. He then noticed the front right occupant laying between the front and the second seats on the floor.

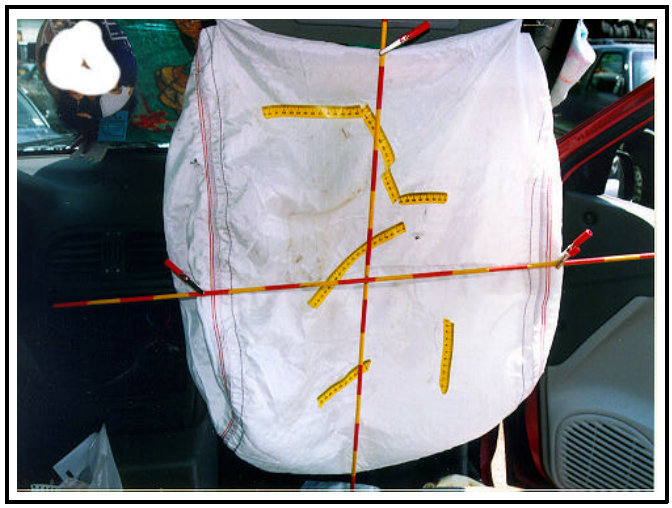


Figure 3. Occupant contact to front right air bag.

The driver of the case vehicle believed that the front right occupant was seated in a normal upright position on the seat. While being interviewed, the mother of the child indicated that the child was hard to control and did not like to keep the lap/shoulder restraints on. It is assumed by this investigator that the child was probably seated upright and in a forward facing position and was not wearing the available lap/shoulder restraints. Due to the pre-impact braking, he was pitched forward towards the top of the instrument panel. He appears to have stuck out his right and left arms. There are indications of contacts to the windshield by his right hand and his forehead. His head was probably rebounding from the windshield when the impact between the case vehicle and the 280 ZX occurred. The windshield was struck by the air bag, there is evidence of fiber imprint onto the glazing. As the front right passenger’s air bag deployed the module cover probably contacted the left side of the front right occupant’s face causing an avulsion (AIS 1) which extended from the left corner of his mouth to the left preauricular area. There was no evidence of occupant contact to module cover. The air bag contacted the front right occupant about his entire face causing numerous abrasions (AIS1). The air bag also contacted his right arm and shoulder areas causing numerous abrasions (AIS1). His right arm appears to have then been flung towards the right A-pillar, shattering the plastic covering around the A-pillar. As the front passenger’s air bag continued its unfolding sequence it contacted the front of the child’s neck and underneath his chin–causing a multiple abrasions (AIS1)--and the front right occupant was lifted upwards. As the air bag fully deployed it “snapped” and accelerated the child’s

Figure 4. Occupant contacts to the front right areas.

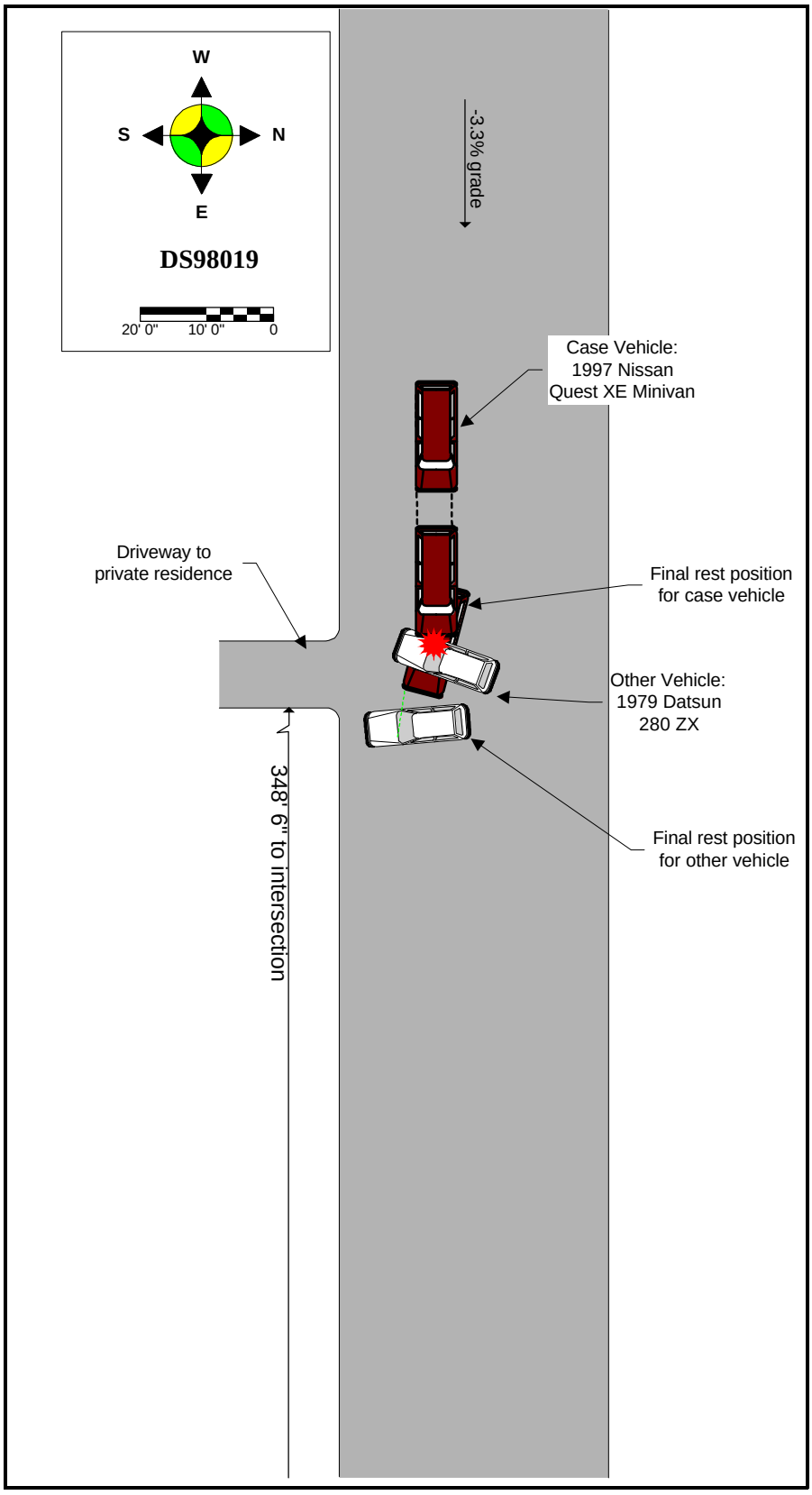
Figure 5. Lower left seat cushion of front right seat.

head rearward. This caused the fatal injuries consisting of a complete transection of the brainstem at the pontine-medullary junction (AIS5) with a complete posterior disarticulation of the base of the skull from the cervical spine at the atlanto-occipital joint (AIS2). He also sustained subarachnoid hemorrhaging (AIS3). The front right occupant was thrown backwards. The front right occupant came to rest on the right side of his face and body between the front left and second seats, facing towards the rear of the vehicle.

Emergency personnel were notified at 1505 hours and arrived at the scene at 1509 hours. Medical aid was administered to the front right occupant but he expired at the scene at 1621 hours.

The driver and the three other occupants/children in the case vehicle were not injured. The driver of the 280 ZX did not report any injuries to the police.

Scene diagram



COLLISION MEASUREMENTS

Reference point: East edge of driveway-located 348.5 feet west from intersection

Reference line: Extension of south curb line of east-west roadway

Data Point	Distance and Direction from RP			Distance and Direction from RL		
	ft	m	d	ft	m	d
Case Vehicle						
Begin R/R skidmark	47	14.3	W	11.5	3.5	N
Impact area	19.25	5.9	W	11.66	3.6	N
End R/R skidmark	15.58	4.7	W	12.58	3.8	N
L/R skidmark - impact area	20	6.1	W	17.17	5.2	N
End L/R skidmark	14.25	4.3	W	18.33	5.6	N
Begin R/F skidmark	27.33	8.3	W	11.58	3.5	N
Impact area	9.17	2.8	W	12	3.7	N
Middle measurement	8.25	2.5	W	11	3.4	N
End R/F skidmark	6.42	2	W	10.42	3.2	N
Begin L/F skidmark	38.66	11.8	W	16.58	5.1	N
Impact area	9.5	2.9	W	17.25	5.3	N
Middle measurement	7.33	2.2	W	16.66	5.1	N
End L/F skidmark	4.92	1.5	W	15.92	4.9	N
Impact between case vehicle and 280 ZX	9.33	2.8	W	14.33	4.4	N
Other vehicle 280 ZX						
Begin L/F	4	1.2	W	10.08	3.1	N
Middle measurement	0.33	0.1	E	9.42	2.9	N
End L/F skidmark	4.33	1.3	E	8.66	2.6	N
Final rest L/R tire	5.25	1.6	E	15.75	4.8	N
Final rest R/R tire	1	0.3	W	14.83	4.5	N

DETAILED INFORMATION

Vehicles

Case Vehicle

Description:	1997 Nissan Quest XE Minivan	
VIN:	4N2DN1119VDXXXXXX	
Odometer:	29,358 km (18,243 mi)	
Engine:	3.0 L EFI V6	
Reported Defects:	None	
Cargo:	Assorted blankets, toys in the rear cargo area.	
Damage Description:	Minor damage across the front bumper, hood, grille area, front right fender, and windshield.	
CDC:	12FDEW1	
Impact Speed[1]:		33.8 km/h (21.0 mph)
Delta V:	Total	16.4 km/h (10.2 mph)
	Longitudinal	-16.3 km/h (-10.2 mph)
	Latitudinal	1.4 km/h (0.9 mph)
	Energy	3,257 joules (2,403 ft-lbs)

Figure 6. Exterior damage to case vehicle.

[1] WinSmash 1.2.1 Damage and trajectory algorithm using size and stiffness coefficients from NHTSA's NCAP test.

The case vehicle is equipped with three rows of seats. The front seats are both box mounted-van type seats. The driver's seat was adjusted to the rear most seat track position and the seatback was slightly reclined (15E rearward). The right front seat was adjusted to the rear most seat track position, and the seatback was reclined (29E rearward). The second and third row seats were both bench types with non-adjustable seatbacks.

The case vehicle was equipped with factory installed driver's and front right passenger's air bags. The driver's air bag was encased within the steering wheel, with upper and lower module covers that opened in an I-pattern. The driver's air bag measured approximately 58 cm (22.8 in) in diameter, and had four horizontal folds with two tethers and two rear vents ports. There was module cover smudging on the left back quadrant of the bag, but no evidence of driver contact. There was no damage to the air bag or the module covers. The front right passenger's air bag was enclosed in a top-mount, type module. The single module cover opens upwards toward the windshield in a hinged fashion. There appeared to be occupant contact to the top part of the module cover–possibly the front right occupant's left hand. The air bag had one tether across the entire face at mid-level, and two rear vents ports. The air bag was rectangular in shape and measured 53 cm (20.9 in) by 60 cm (23.6). There was evidence of contact by the front right occupant in the upper left quadrant of the air bag. The air bag was not damaged.

Other Vehicle

Description:	1979 Datsun 280 ZX	
VIN:	HS130XXXXXX	
Odometer:	235, 756 km (146,496)	
Engine:	V6	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate damage to the right side, right side glazing, and windshield.	
CDC:	02RYEW3	
Impact Speed[2]:	9.1 km/h (5.6 mph)	
Delta V:	Total	25.2 km/h (15.7 mph)
	Longitudinal	-11.1 km/h (-6.9 mph)
	Latitudinal	-22.6 km/h (-14.1 mph)
	Energy	39,690 joules (29,292 ft-lbs)

Figure 7. Exterior damage to 280 ZX.

[2] Calculated using WinSmash 1.2.1 Trajectory run.

Occupants

Case Vehicle	Occupant 1 (Driver)	Occupant 2
Age/Sex:	28/Male	3/Male
Seated Position:	Left front	Right front
Seat Type:	Box mounted	Box mounted
Height:	191 cm (75 in.)	102 cm (40 in.)–per autopsy report
Weight:	125 kg (275 lbs)	20 kg (45 lbs)
Occupation:	Unknown	NA
Pre-existing Medical Condition:	Not known	None indicated
Alcohol/Drug Involvement:	None	NA
Driving Experience:	. 12 years	NA
Body Posture:	Normal, upright	Unknown, mother indicated child hard to control and did not like wearing lap/shoulder belts.
Hand Position:	Both hands presumed on steering wheel, unknown positions.	Unknown pre-braking. Post-braking it appears he was reaching with right hand to brace himself.
Foot Position:	Due to pre-impact braking, right foot presumed to be on brake pedal.	Unknown
Restraint Usage:	Lap and shoulder belts not used	Lap and shoulder belts not used

Occupants (Cont.)

Case Vehicle	Occupant 3	Occupant 4	Occupant 5
Age/Sex:	1/Female	10/Male	9/Female
Seated Position:	Second seat right	Third seat left	Third seat center
Seat Type:	Bench with folding back	Bench with folding back	Bench with folding back
Height:	Unknown by mother	Unknown by mother	Unknown by mother
Weight:	16 kg (35 lbs)	40 kg (87 lbs)	38 kg (84 lbs)
Occupation:	NA	NA	NA
Pre-existing Medical Condition:	Unknown	Unknown	None
Alcohol/Drug Involvement:	NA	NA	NA
Driving Experience:	NA	NA	NA
Body Posture:	Seated in child carrier, unknown which direction it was facing	Unknown	Unknown
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Lap/shoulder restraints available, but not used to anchor carrier to vehicle seat. Unknown if child carrier harness used.	Indicated to police that available lap/shoulder restraints not used. Mother indicated that child later said he was wearing lap/shoulder restraints.	Indicated to police that available lap/shoulder restraints not used. Mother indicated that child later said she was wearing lap/shoulder restraints.

Occupant

Other Vehicle	Occupant 1 (Driver)
Age/Sex:	67/Male
Seated Position:	Left front
Seat Type:	Bucket
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	Unknown
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Presumed upright
Hand Position:	On the steering wheel, unknown positions
Foot Position:	Right foot on the accelerator
Restraint Usage:	Lap/shoulder per police report

Injuries and Injury Mechanisms

Case Vehicle

Driver: Not injured

	INJURY	OIC CODE	ICD-9	SOURCE
Occupant 2:	Complete transection of the brainstem at the pontine-medullary junction	140218.6, 8	847.0	Air bag
	Complete posterior disarticulation of the base of the skull from the cervical spine at the atlanto-occipital joint.	650208.2, 6	806.01	Air bag
	Subarachnoid hemorrhage	140684.3, 6	852.2	Air bag
	Pulmonary edema and congestion	441402.3, 9	861.21	Air bag
	A 13.5 x 0.9 cm (5.3 x 0.4 in.) arcuate abrasion that extends from above right ear to left temporal area at the hairline	190202.1, 1	910.0	Air bag
	A 7 x 1.9 cm (2.8 x 0.8 in.) abrasion to right frontal area above the right eyebrow.	290202.1, 7	910.0	Air bag
	A 1.2 x 0.5 cm (0.5 x 0.2 in.) abrasion above the right lateral palpebral fissure.	290202.1, 1	910.0	Air bag
	A 3.2 x 0.6 cm (1.3 x 0.2 in.) abrasion lateral to the right lateral palpebral fissure with a 4.2 x 2.8 cm (1.7 x 1.1 in.) area of abrasion present below the right eye.	290202.1, 1 290202.1, 1	910.0	Air bag
	A 3 x 2.1 cm (1.2 x 0.8 in.) contusion on the lateral left upper and lower eyelids.	290402.1, 2	921.1	Air bag

	A 2.5 x 0.8 cm (1 x 0.3 in.) abrasion adjacent to the right corner of the mouth.	290202.1, 8	910.0	Air bag
	A 7.2 x 2 cm (2.8 x 0.8 in.) gaping laceration extends from the left corner of the mouth to the left preauricular area. The tissue has been avulsed to the level of the zygomatic process.	290802.1, 2	873.41	Air bag module cover
	A large area of abrasion to the undersurface of the chin extending from the right angle of the mandible across the entire under surface to the left preauricular area and left cheek.	290202.1, 8	910.0	Air bag
	A 12.5 x 6.8 cm (4.9 x 2.7 in.) band-like abrasion extends across the anterior neck below the thyroid notch.	390202.1, 5	910.0	Air bag
	A 25.3 x 8 cm (10 x 3.2 in.) abrasion extends from the top of the right shoulder to the right volar wrist.	790202.1, 1	910.0	Air bag

Occupant 3: Not injured

Occupant 4: Not injured

Occupant 5: Not injured

Injuries and Injury Mechanisms (Cont..)

Other Vehicle

Driver:	No injuries reported to police

Occupant Kinematics

The driver of the case vehicle is assumed to have seated in a forward facing, upright normal seated position. His hands were on the steering wheel at the moment of impact with his right foot depressing the brake pedal. On impact with the 280 ZX, the driver of the case vehicle was struck in the face by the air bag, “knocked out” and lost his breath. This is presumed to mean that he was stunned for a few seconds. He exited the vehicle and ran around to the right side and rolled opened the right side door. He then noticed the front right occupant laying between the front and the second seats on the floor.

The driver of the case vehicle believed that the front right occupant was seated in a normal upright position on the seat. The mother indicated that the child was hard to control and did not like to keep the lap/shoulder restraints on. It is assumed by this investigator that the child was probably seated upright and in a forward facing position and was not wearing the available lap/shoulder restraints. Due to the pre-impact braking, he was pitched forward towards the top of the instrument panel. He appears to have stuck out his right and left arms. There are indications of contacts to the windshield by his right hand and his forehead. His head was probably rebounding from the windshield when the impact between the case vehicle and the 280 ZX occurred. The windshield was struck by the air bag, there is evidence of fiber imprint onto the glazing. As the front right passenger’s air bag deployed the module cover probably contacted the left side of the front right occupant’s face causing an avulsion (AIS 1) which extended from the left corner of his mouth to the left preauricular area. The air bag contacted the front right occupant about his entire face causing numerous abrasions (AIS1). The air bag also contacted his right arm and shoulder areas causing numerous abrasions (AIS1). His right arm appears to have then been flung towards the right A-pillar, shattering the plastic covering around the A-pillar. As the front passenger’s air bag continued its unfolding sequence it contacted the front of the child’s neck and underneath his chin–causing a multiple abrasions (AIS1)--and the front right occupant was lifted upwards. As the air bag fully deployed it “snapped” and accelerated the child’s head rearward. This caused the fatal injuries consisting of a complete transection of the brainstem at the pontine-medullary junction (AIS5) with a complete posterior disarticulation of the base of the skull from the cervical spine at the atlanto-occipital joint (AIS2). He also sustained subarachnoid hemorrhaging (AIS3). The front right occupant was thrown backwards. The front right occupant came to rest on the right side of his face between the front left and second seats facing towards the rear of the vehicle.

The second seat right occupant was in a child carrier. She was removed from the case vehicle by a bystander who indicated that the child carrier was not anchored to the vehicle seat by the available lap/shoulder restraints.

Both third seat occupants responded to the pre-impact braking and crash with the 280 ZX by moving forward and probably contacting the second seat back cushion.