

On-scene Investigation / Vehicle to Vehicle  
Dynamic Science, Inc. / Case Number: DS01-013  
1997 Nissan Quest  
North Carolina  
May, 2001

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*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 crash occurred near a three-leg intersection in North Carolina in May, 2001 at 1508 hours. The westbound leg of the intersection is comprised of two westbound and two eastbound travel lanes. The road surface is asphalt. It was dry and free of defects. The speed limit for westbound traffic is 56 km/h (35 mph).  The case vehicle, a 1997 Nissan Quest minivan was driven by a properly restrained 30-year-old female who was traveling westbound at a police estimated speed of 48 km/h (30 mph). There were four additional occupants in this vehicle. The front, right seat was occupied by an unrestrained 9-year-old male. A 3-year-old male occupied the rear left seat position and was secured in a child safety seat. An unrestrained 7-year-old female occupied the rear right seat position. There was an unrestrained 9-year-old female occupying the third seat.  The other vehicle was a 1987 S1500 Jimmy sport utility vehicle driven by a 19-year-old female traveling at a police reported speed of 48 km/h (30 mph).  The case vehicle was proceeding westbound in the second lane of a undivided four-lane roadway when the other vehicle began slowing due to traffic. It appears that the driver of the case vehicle braked, but was unable to stop in time. The front of the case vehicle (12FDEW1) impacted the rear of the GMC Jimmy in a front to rear, in-line, axial collision. The case vehicle sustained a longitudinal delta v of -14.3 km/h (-8.9 mph). Both the driver's steering wheel mounted air bag and the front right passenger's top mounted air bag deployed as a result of the frontal impact.  The unrestrained 9-year-old male front right occupant pitched forward during braking and impact. His right arm engaged the deploying air bag and sustained the following injuries: abrasions, distal humerus lateral condyle fracture, complete avulsion of the brachial plexus, complete avulsion of the sub-clavian artery, complete avulsion of the lower brachial nerve roots from the spinal cord, and a complete avulsion of the upper brachial nerve roots. He also sustained contusions to the right side of the face. There were no injuries reported for the driver of the case vehicle, the second seat left occupant, and the third seat middle occupant. Type "C" (possible injuries) were reported for the second seat right occupant.					
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**Dynamic Science, Inc.**  
**Accident Investigation**  
**Case Number: DS01-013**

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**BACKGROUND:**

Description: This air bag related front right passenger serious injury case was generated in response to notification from a local medical center. NHTSA was notified of the case on June 14, 2001. This investigation was conducted on scene in North Carolina on June 27, 2001.

Investigation Type: On-scene

Crash Location: North Carolina

Crash Date: May, 2001

Notification Date: June 14, 2001

Field Work Completed: June 27, 2001

**SUMMARY:**

The crash occurred near a three-leg intersection in North Carolina in May, 2001 at 1508 hours. The westbound leg of the intersection is comprised of two westbound and two eastbound travel lanes. The road surface is asphalt. It was dry and free of defects. There is a -6% down grade approaching the intersection. There are no applicable traffic controls for westbound traffic. The speed limit for westbound traffic is 56 km/h (35 mph).

The case vehicle, a 1997 Nissan Quest minivan was driven by a properly restrained 30-year-old female who was traveling westbound at a police estimated speed of 48 km/h (30 mph). There were four additional occupants in this vehicle. The front, right seat was occupied by an unrestrained 9-year-old male. A 3-year-old male occupied the second seat left and was secured in a child safety seat. An unrestrained 7-year-old female occupied the second seat right. There was an unrestrained 9-year-old female occupying the third seat, middle position.



**Figure 1.** Overview of approach to impact area



**Figure 2.** Frontal overhead view showing frontal deformation to case vehicle

The other vehicle was a 1987 S1500 Jimmy sport utility vehicle driven by a 19-year-old female traveling at a police reported speed of 48 km/h (30 mph).

The case vehicle was proceeding westbound in the second lane of an undivided four-lane roadway when the other vehicle began slowing due to traffic. The police report a travel speed of 16 km/h (10 mph). The driver of the case vehicle saw the other vehicle slowing and began braking, but she was unable to stop the vehicle in time. The front of the case vehicle (12FDEW1) impacted the rear of the GMC Jimmy in a front to rear, in-line, axial collision. This was an underriding type impact to the case vehicle.

At the time that the case vehicle was inspected, the front bumper, fascia, hood and front fenders were removed. The upper radiator support had been manipulated from its post-crash position so a crush profile was derived by measuring to areas of the upper radiator support that had not been altered and direct measurements to the radiator. This crush profile was averaged with the front bumper damage which was described as none. Although the SAE Vehicle Measurement protocol was closely followed, the crush profile and WinSmash results should be utilized as a marginal guideline for determining energy calculations.

The case vehicle sustained a longitudinal delta v of -14.3 km/h (-8.9 mph)<sup>1</sup>. This frontal collision appeared to be at the low end of the threshold necessary for air bag deployment. Both the driver's steering wheel mounted air bag and the front right passenger's top mounted air bag deployed as a result of the frontal impact. The involved vehicles came to rest in lane two of the four-lane roadway and were facing west. The case vehicle was towed from the crash location and was subsequently determined to be a total loss by the insurance company. The damage to the other vehicle was described as light and the vehicle was subsequently driven from the crash location.



**Figure 1.** Front, left three-quarter view of case vehicle



**Figure 4.** Full frontal view of case vehicle interior showing deployed air bags

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<sup>1</sup>Calculated using the Missing Vehicle Algorithm of the WinSmash 1.2.1 program, with offset impact option on. Stiffness derived from NCAP test 2067.

The unrestrained 9-year-old male who occupied the front right seated position initially responded to the braking forces by pitching forward. He likely raised his arms in a protective gesture. At impact he responded to the 12 o'clock impact force by moving directly forward. His right arm was above the air bag module cover and likely contacted the windshield. There was no contact to the module cover itself. There was damage noted to the glove box door which was the result of knee loading from this occupant. While his arm was in contact with the windshield, the air bag deployed upward and rearward. The air bag struck his right arm, near the elbow. With his arm pinned by the windshield, the force was directed upward through the joint. This occupant sustained the following injuries to the right arm: burns/abrasions, and a distal humerus lateral condyle fracture. He sustained a complete avulsion of the brachial plexus, complete avulsion of the sub-clavian artery, complete avulsion of the lower brachial nerve roots from the spinal cord, and a complete avulsion of the upper brachial nerve roots. He also sustained contusions to the right side of the face.



**Figure 6.** Front, right view showing deployed frontal air bags.

When the boy arrived at the trauma center the arm had no pulse. There was a large amount of blood loss. It is doubtful that the child will ever regain use of his arm, because of excessive nerve damage.

There were no injuries reported for the driver of the case vehicle, the second seat left occupant, and the third seat middle occupant. Type "C" (possible injuries) were reported for the second seat right occupant.

Type "C" (possible injuries) were reported for the driver of the other vehicle.

### Scene Diagram

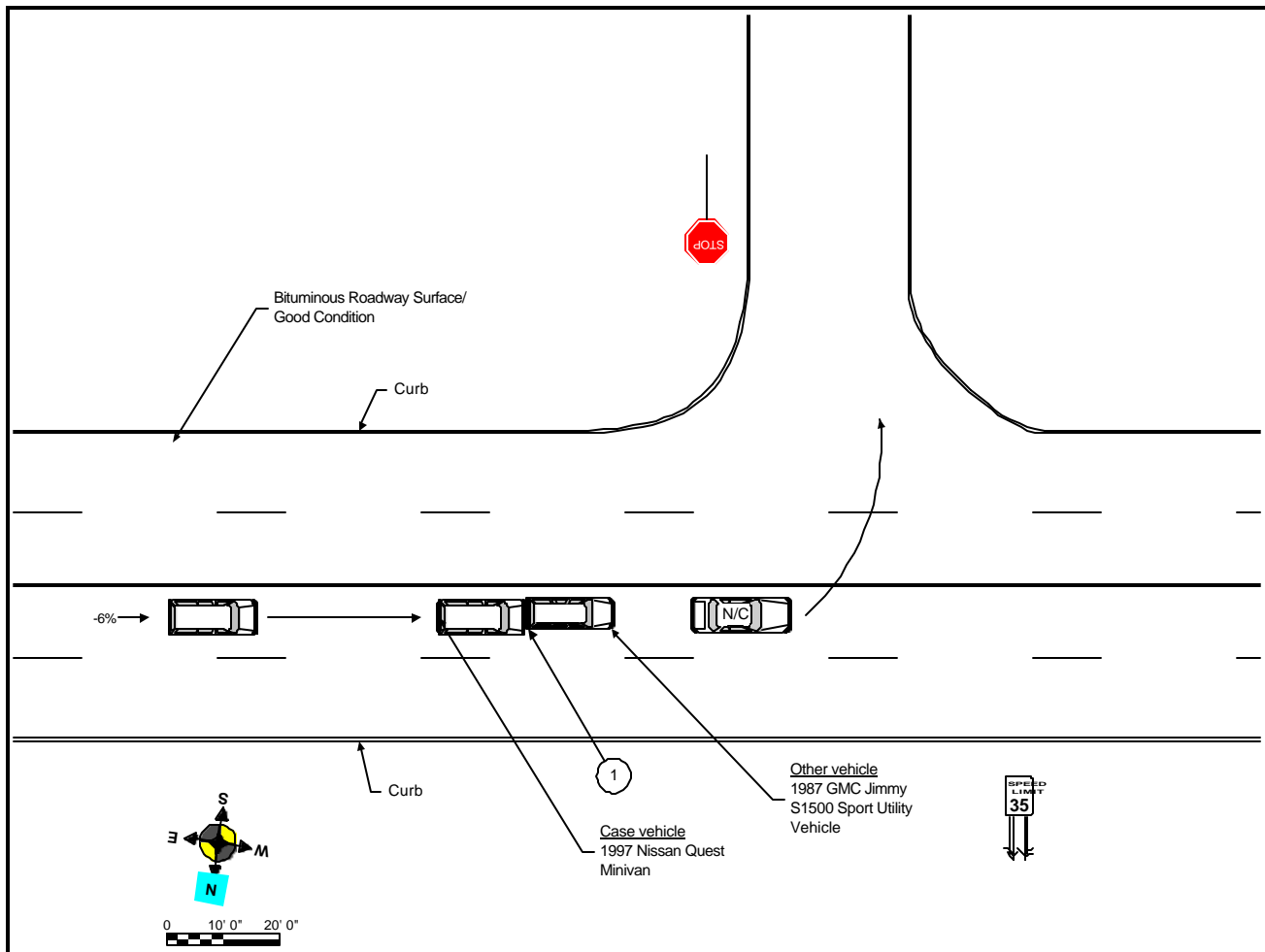


Figure 6. Scene Diagram

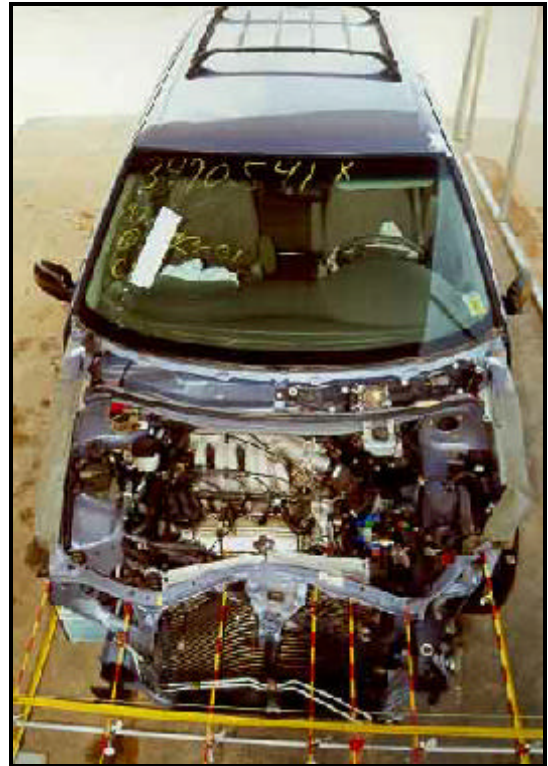


**DETAILED INFORMATION****Vehicles**Case vehicle

Description:	1997 Nissan Quest minivan	
VIN:	4N2DN1111VDxxxxxx	
Odometer:	67,379 km (41,869 miles)	
Engine:	3.0 L V6	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate frontal damage. Bumper override. There was 3 cm (1.2 in.) of stroke to the right EAD. Police indicate a TAD of FD-6 with a damage estimate of \$8,000. There was intrusion into the second seat row by the second seat seatback caused by the rear third row seat occupant. All the doors remained functional.	
CDC:	12FDEW1	
Delta V:	Total	14.3 km/h (8.9 mph)
	Longitudinal	-14.3 km/h (-8.9 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	6,850 joules (5,053 ft-lbs)

The case vehicle was equipped with cloth fabric-covered bucket seats at the front outboard seat positions. The front left seat was adjusted to the rear-most track position at the time of the inspection. This seat position was equipped with a lap and shoulder belt. The shoulder belt adjuster was in the full up position. The seat belt was being used at the time of the crash. The front right seat was adjusted to the rear-most track position at the time of the inspection. This seat position was equipped with a lap and shoulder belt with a switchable retractor. The seat belt was not being used at the time of the crash.

The second seat was a two-passenger, cloth-covered reclining bench seat. The second seat left was equipped with a lap and shoulder belt with a switchable retractor. The switch status is not known. The seat belt was being used in conjunction with an unknown type child safety seat. The second seat right was equipped with a available lap and shoulder belt with switchable retractor.

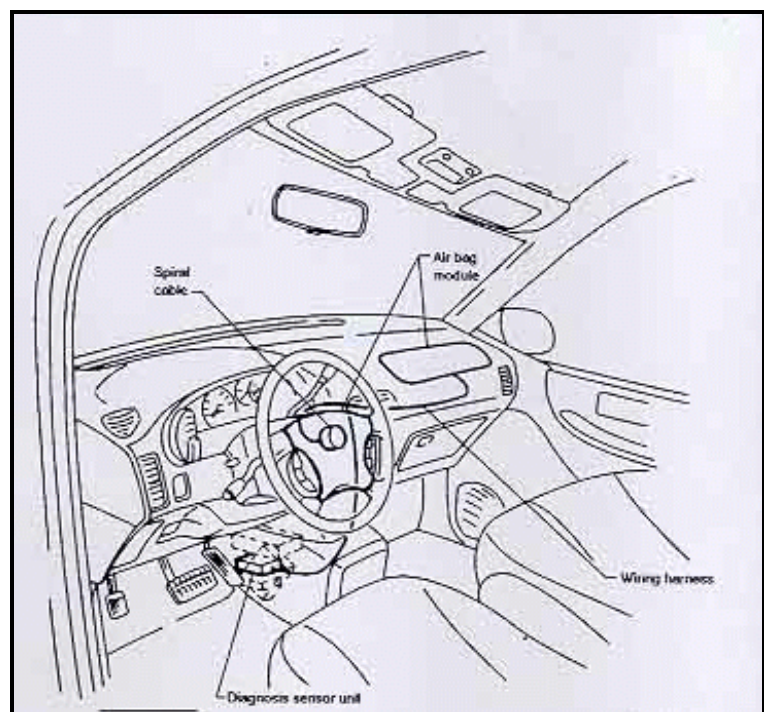


**Figure 8.** Overview of frontal damage

The third seat was a reclining cloth-covered bench seat. The third seat middle was position was equipped with a lap belt that was not used during the crash.

There was 47 cm (18.5 in) between the front of the second seat and the back of the front seat at shoulder level and 21 cm (8.3 in.) at leg level.

The case vehicle was equipped with a driver's air bag and a front right passenger's air bag. The driver's air bag was circular in shape and measured 67 cm (26.3 in) and had circular vent ports at the 11 and 1 o'clock positions. The air bag had four tethers and there were four visible horizontal and vertical folds; it was not damaged. The H-configuration air bag module cover was not damaged. The front right passenger's air bag was rectangular in shape and measured 54 cm (21.2 in) high by 72 cm (28.3 in) wide and had circular vent ports at the 10 and 2 o'clock positions.



**Figure 9.** SRS component locations

There were no tethers. There was no damage or visible contact to the air bag or the module cover.

Other vehicle

Description:	1987 GMC S1500 Jimmy sport utility vehicle	
VIN:	1GKCT18R5H8xxxxxx	
Odometer:	Unknown	
Engine:	2.8L V6	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Police indicate a TAD of BD-3 with a damage estimate of \$7,000.	
CDC:	Unknown	
Delta V:	Total	14.7 km/h (9.1 mph)
	Longitudinal	14.7 km/h (9.1 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	23,824 joules (16,565 ft-lbs)

**Occupants**

<u>Case vehicle</u>	Occupant 1	Occupant 2
Age/Sex:	30/Female	9/Male
Seated Position:	Front left	Front right
Seat Type:	Fabric covered bucket seat, seat was adjusted to the rear-most track position	Fabric covered bucket seat, seat was adjusted to the rear-most track position
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	NA
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Unknown	Likely in front, at shoulder level, in a protective gesture
Foot Position:	Right foot on brake, left on floor board	Unknown
Restraint Usage:	Lap and shoulder belt available, used properly	Lap and shoulder belt available, not used
Air bag:	Air bag available, deployed	Air bag available, deployed

<u>Case vehicle</u>	Occupant 3	Occupant 4	Occupant 5
Age/Sex:	3/Male	7/Female	9/Female
Seated Position:	Second seat left	Second seat right	Third seat middle
Seat Type:	Fabric covered, reclining bench	Fabric covered, reclining bench	Fabric covered, reclining bench
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	Unknown	Unknown
Occupation:	NA	NA	NA
Pre-existing Medical Condition:	None noted	None noted	None noted
Alcohol/Drug Involvement:	NA	NA	NA
Driving Experience:	NA	NA	NA
Body Posture:	Unknown	Unknown	Unknown
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Child seat used in conjunction with lap and shoulder belt	Lap and shoulder belt available, not used	Lap belt available, not used
Air bag:	None available	None available	None available

Other vehicle

Age/Sex:	19/Female
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report

**Injuries and Injury Mechanisms****Case vehicle**

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Not injured			
Front right	Distal humerus lateral condyle fracture, right	752604.3,1	812.42	Air bag
	Complete avulsion of the brachial plexus	630226.3,6	953.4	Air bag
	Complete avulsion of the sub-clavian artery, right	721008.3,1	901.1	Air bag
	Complete avulsion of the upper and lower brachial nerve roots from the spinal cord	630266.3,0	953.4	Air bag
	Contusion, right side of face	290402.1,1	920.0	Air bag
	Abrasions, right forearm	790602.1,1	913.0	Air bag
	Abrasions, right upper arm	790602.1,1	912.0	Air bag
	Abrasions, right hand	790602.1,1	913.0	Windshield
	Abrasion, right side of neck	390202.1,1	910.0	Air bag
Second seat left	Not injured			
Second seat right	Type "C" (possible injuries) were reported			
Third seat middle	Not injured			



**Other vehicle**

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Type "C" (possible injuries) were reported			

## Occupant Kinematics

The 30-year-old driver of the case vehicle was seated in the cloth-covered bucket seat in a normal, upright fashion. The seat was adjusted to the rear-most track position at the time of the inspection. She was wearing the available lap and shoulder belt. The shoulder belt adjuster was in the full up position. Prior to impact, her right foot was on the brake. At impact, she pitched forward and engaged the deployed air bag. She continued moving forward and engaged the lower instrument panel with both knees—leaving scuff marks. She did not, however, report any injuries.

The 9-year-old male front right occupant was seated in the cloth-covered bucket seat in a normal, upright fashion. The seat back was slightly reclined. The seat was adjusted to the rear-most track position at the time of the inspection. He was not wearing the available lap and shoulder belt. He was facing to the left to some degree. This occupant initially responded to the braking forces by pitching forward. He likely raised his arms in a protective gesture. At impact responded to the 12 o'clock impact force by moving directly forward. His right arm was above the air bag module cover and likely contacted the windshield. There was no contact to the module cover itself. There was damage noted to the glove box door which was the result of knee loading from this occupant. While his arm was in contact with the windshield, the air bag deployed upward and rearward. The air bag struck his right arm, near the elbow. With his arm pinned by the windshield, the force was directed upward through the joint. This fractured the distal humerus lateral condyle. The deploying air bag pushed his arm up sharply causing the following injuries to his right arm/shoulder area: burns/abrasions, complete avulsion of the brachial plexus, complete avulsion of the sub-clavian artery, complete avulsion of the lower brachial nerve roots from the spinal cord, and a complete avulsion of the upper brachial nerve roots. He also sustained contusions to the right side of the face.



Figure 10. Front left seat position



Figure 11. Front right seat position



Figure 12. Windshield contact



**Figure 13.** Front right occupant injuries

The 3-year-old male second seat left occupant was seated in a forward facing child seat of unknown make and model. This seat position was equipped with a lap and shoulder belt with a switchable retractor. The switch status is not known. During braking, he likely pitched forward to some degree but was secured in the child seat both at this point and during impact. There were no injuries reported.

The 7-year-old female second seat right occupant was seated in the cloth-covered bench seat (with folding back) in what is presumed to be a normal upright fashion. She was not wearing the available lap and shoulder belt with a switchable retractor. Type "C" (possible injuries) were reported for this occupant.



**Figure 14.** Right arm fracture

The 9-year-old female third seat middle seat occupant was seated in the cloth-covered bench seat (with folding back) in what is presumed to be a normal upright fashion. She was not wearing the available manual lap belt. During braking and the subsequent impact, this occupant pitched forward and struck the rear of the second seat—deforming it forward. There were no injuries reported.



**Figure 15.** Rear of second seat - contact from rear middle seat occupant