TRANSPORTATION SCIENCES
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REMOTE AIR BAG RELATED CHILD PASSENGER FATALITY INVESTIGATION SCI TECHNICAL SUMMARY REPORT

VERIDIAN CASE NO. CA00-052

SUBJECT VEHICLE: 1994 NISSAN ALTIMA

LOCATION - STATE OF SOUTH CAROLINA

CRASH DATE - DECEMBER 1999

Contract No. DTNH22-94-D-07058

Prepared for:

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National Highway Traffic Safety Administration
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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 are 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 remote investigation focused on a 1994 Nissan Altima which was equipped with air bags for the driver and front right positions that deployed as a result of a frontal impact with a 1989 Oldsmobile 98 Regency. The Altima was occupied by a 26-year-old female driver, a 16-year-old female front right passenger, a 6-year-old male on the lap of the front right passenger, and three male children in the rear seat ranging from 2 to 16 years of age. The 2-year-old was reportedly restrained in a child safety seat, however, the remaining occupants were unrestrained. The driver of the Oldsmobile initiated a left turn across the path of the Altima and the front right area of the Altima struck the front right area of the Oldsmobile. The impact induced deceleration was sufficient to deploy the frontal air bag system in the Altima. Pre-crash braking displaced the unrestrained occupants of the Altima forward. At impact, the occupants initiated forward trajectories. The driver struck the deployed driver's air bag and did not sustain injury. The front right passenger sustained a police-reported incapacitating injury from probable occupant-to-occupant contact with the 6-year-old. The child on her lap probably prevented contact with the front right passenger's air bag. She was transported to a local hospital, but her admission status was not reported. The 6-year-old child seated on the lap of the front right passenger was probably positioned over the front right passenger's air bag cover flap as the air bag deployed. The air bag most likely expanded against the underside of his chin and against his chest which resulted in a cervical spine dislocation. He probably rebounded against the front right passenger. He was transported to a local hospital and pronounced dead. The only available medical data was a coroner's report which stated the cause of death as cervical dislocation. Although not identified, this child passenger probably sustained a spinal cord and/or brain stem injury that contributed to his death. The rear seated children did not sustain injury, however the police reported that the 2-year-old male was transported to a local hospital. His admission status was not reported.

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BACKGROUND

Figure 1. 1994 Nissan Altima

This remote investigation focused on a 1994 Nissan Altima **(Figure 1)** which was equipped with air bags for the driver and front right positions that deployed as a result of a frontal impact with a 1989 Oldsmobile 98 Regency. The Altima was occupied by a 26-year-old female driver, a 16-year-old female front right passenger, a 6-year-old male on the lap of the front right passenger, and three male children in the rear seat ranging from 2 to 16 years of age. The 2-year-old was reportedly restrained in a child safety seat, however, the remaining occupants were unrestrained. The driver of the Oldsmobile initiated a left turn across the path of the Altima and the front right area of the Altima struck the front right area of the Oldsmobile. The impact induced deceleration was sufficient to deploy the frontal air bag system in the Altima. Pre-crash braking displaced the unrestrained occupants of the Altima forward. At impact, the occupants initiated forward trajectories. The driver struck the deployed driver's air bag and did not sustain injury. The front right passenger sustained a police-reported incapacitating injury from probable occupant-to-occupant contact with the 6-year-old. The child on her lap probably prevented contact with the front right passenger's air bag. She was transported to a local hospital, but her admission status was not reported. The 6-year-old child seated on the lap of the front right passenger was probably positioned over the front right passenger's air bag cover flap as the air bag deployed. The air bag most likely expanded against the underside of his chin and against his chest which resulted in a cervical spine dislocation. He probably rebounded against the front right passenger. He was transported to a local hospital and pronounced dead. The only available medical data was a coroner's report which stated the cause of death as cervical dislocation. Although not identified, this child passenger probably sustained a spinal cord and/or brain stem injury that contributed to his death. The rear seated children did not sustain injury, however the police reported that the 2-year-old male was transported to a local hospital. His admission status was not reported.

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for child fatalities that occurred in vehicles equipped with air bags. The crash occurred in December 1999 and was assigned to the Veridian Special Crash Investigations Team on November 3, 2000 as a remote investigation effort. Police photographs, a police crash report, a coroner's report, and a death certificate were obtained which provide the basis for this narrative report.

SUMMARY

Crash Site

This two vehicle crash occurred during the nighttime hours of December 1999. At the time of the crash, it was dark and no roadway illumination was present. There were no adverse weather conditions present as the asphalt road surface was dry. The crash occurred on the inboard northbound lane of a four-lane primary roadway. The north/south roadway consisted of two travel lanes in each direction separated by a double-yellow centerline and reflective yellow markers. The outboard edges of the roadway were bordered by concrete curbs and raised dirt shoulders.

Pre-Crash

The 26-year-old female driver of the 1994 Nissan Altima was operating the vehicle on the inboard northbound lane of a four-lane roadway. Police reported that the driver of the 1989 Oldsmobile 98 Regency was intoxicated. The inattentive driver of the 98 Regency was operating the vehicle in the southbound inboard lane and initiated a left turn across the path of the Nissan. The driver of the Nissan realized the impending event and applied the brakes in full lockup. Skid marks were noted in the Nissan's trajectory in the on-scene police photographs **(Figure 2)**. Estimated lengths of the skid marks were approximately 15 m (50').

Figure 2. On-scene photograph showing skid marks from the Altima

Crash

As the Oldsmobile Regency crossed the centerline, the front right area of the Nissan Altima impacted the front right area of the Oldsmobile. Impact resulted in minor damage to both vehicles. The front right corner of the Altima slightly underrode the front right corner of the Regency due to pre-crash braking. The resultant directions of force were in the 12 o'clock sector for the Altima and in the 1 o'clock sector for the Regency. The impact induced deceleration was sufficient to deploy the frontal air bag system in the Altima. The damage algorithm of the WinSMASH program computed total velocity changes of 17.0 km/h (10.6 mph) for the Altima and 15.0 km/h (9.3 mph) for the Regency based on the estimated crush profiles of both vehicles. The longitudinal and lateral components were -16.7 km/h (-10.4 mph) and 3.0 km/h (1.8 mph), respectively for the Altima. The longitudinal and lateral components were -13.0 km/h (-8.1 mph) and -7.5 km/h (-4.7 mph), respectively for the Regency. The results obtained from the WinSMASH program appear conservative given the crash configuration. The Missing Vehicle and Barrier routines were also used to compute velocity changes for comparison. The results were slightly higher for the Barrier routine and slightly lower for the Missing Vehicle routine, each within 3.2 km/h (2.0 mph) of the original output. The Nissan was redirected rearward and rotated clockwise (CW) approximately 30 degrees. It came to rest straddling the centerline facing northeast **(Figure 3)**. The

Figure 3. Crash site showing final rest positions

Regency rotated counterclockwise (CCW) approximately 50 degrees from impact to final rest. It came to rest facing east straddling a private driveway.

Post-Crash

It was not known how the occupants exited the vehicles. The driver and rear seated passengers of the Nissan Altima were not injured, however, the 2-year-old male that was seated in the child safety seat was transported to a local hospital. The front right passenger and the 6-year-old child on her lap were both transported to a local hospital. The 6-year-old male child was pronounced dead upon arrival at the hospital. The occupants of the Oldsmobile Regency did not sustain injuries and did not receive medical treatment.

VEHICLE DATA - 1994 Nissan Altima

The 1994 Nissan Altima was identified by the Vehicle Identification Number (VIN): 1N4BU31D3RC (production sequence omitted). The vehicle was a four-door sedan and was equipped with a 2.4 liter, 4 cylinder engine, front wheel drive, 5-speed standard transmission, power assisted brakes, power assisted steering, tilt steering wheel, power windows, power door locks and a power sun/moon roof. The seating was configured with front bucket seats with adjustable head restraints and a rear bench seat. The front seating positions were equipped with manual 3-point lap and shoulder belts with sliding latch plates. The rear outboard positions were also equipped with manual 3-point lap and shoulder belts with sliding latch plates. The rear center position was equipped with a lap belt. A forward-facing child safety seat with a T-shield was positioned in the rear right position. The retractor was not a switchable type, and there was no locking clip installed on the restraint webbing.

VEHICLE DAMAGE

Exterior Damage - *1994 Nissan Altima*

The 1994 Nissan Altima sustained minor frontal damage as a result of the impact with the Oldsmobile Regency. The direct contact damage began approximately 20 cm (8") to the right of the centerline and extended laterally along the frontal plane to the right bumper corner **(Figure 4)**. The combined direct and induced damage involved the entire frontal plane of the vehicle. The bumper fascia was abraded and crushed rearward on the right side from direct contact **(Figure 5)**. The maximum crush was estimated to be 8 cm (3") and was located at C6 on the front right bumper corner. The right headlamp assembly was displaced. The grille was separated on the right side. The hood was displaced rearward and buckled on the right side. A depression and abrasions were noted on the hood above the right edge of the grille from engagement against the front right corner of the Regency. The Collision Deformation Classification (CDC) for the impact with the Regency was 12-FREW-1. Six crush

Figure 4. Frontal damage to the Nissan Altima

Figure 5. Right side view of frontal damage

measurements were estimated along the Altima's bumper and were as follows: C1 = 0 cm, C2 = 1 cm (.5"), C3 = 3 cm (1"), C4 = 5 cm (2"), C5 = 5 cm (2"), C6 = 8 cm (3").

Interior Damage - *1994 Nissan Altima*

Interior damage to the 1994 Nissan Altima was minor. The windshield was fractured from the front right passenger's air bag cover flap.

Exterior Damage - *1989 Oldsmobile 98 Regency*

The 1989 Oldsmobile Regency sustained minor frontal damage as a result of the impact with the Nissan Altima. The Regency was equipped with Energy Absorbing Devices (EAD's) behind the front bumper. The status of the EAD's could not be determined from the available police photographs. The direct damage began approximately 65 cm (25.6") to the right of the centerline and extended laterally to the right bumper corner **(Figure 6)**. The combined direct and induced damage involved the entire frontal width of the vehicle. The front right bumper corner was crushed downward and rearward. The maximum crush was estimated to be 25 cm (10") and was located at C6 at the front right bumper corner. The entire bumper fascia was displaced to the left. The right front fender was slightly buckled inward from rearward displacement. The CDC for the impact with the Altima was 01-FREE-2. Six crush measurements along the bumper were estimated from the police photographs and were as follows: C1 = 2 cm (1"), C2 = 5 cm (2"), C3 = 10 cm (4"), C4 = 15 cm (6"), C5 = 20 cm (8"), C6 = 25 cm (10").

Figure 6. Frontal damage to Oldsmobile 98 Regency

FRONTAL AIR BAG SYSTEM - 1994 Nissan Altima

The 1994 Nissan Altima was equipped with frontal air bags for the driver and front right passenger positions **(Figure 7)** that deployed as a result of the impact with the 1989 Oldsmobile Regency. The driver's air bag was housed in the center of the steering wheel with a single cover flap design hinged at the top aspect. The air bag was vented by two ports located at the 11 and 1 o'clock positions.

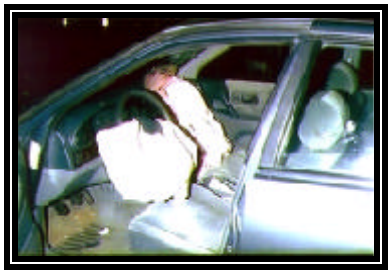

Figure 7. Frontal air bag system in the Nissan Altima

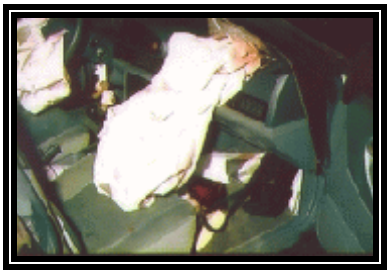

Figure 8. Front right passenger's air bag

The front right passenger's air bag **(Figure 8)** deployed from a top-mounted module with a single cover flap design hinged at the forward aspect. Contact evidence on the air bag and cover flap could not be identified in the police photographs.

OCCUPANT DEMOGRAPHICS - 1994 Nissan Altima

Driver

Age/Sex:	26-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Appeared to be in the mid-track position in on-scene photographs
Manual Restraint Use:	Unrestrained
Usage Source:	Police report
Eyewear:	Unknown
Type of Medical Treatment:	Did not receive medical treatment

Driver Kinematics

The 26-year-old driver was presumed to be seated in an upright posture with the seat track adjusted to the mid-track position. The seat back was slightly reclined in the on-scene photographs. The driver was not restrained by the available manual 3-point lap and shoulder belt. At impact, the frontal air bag system deployed and she initiated a forward trajectory. She struck the deployed driver's air bag which mitigated contact with the steering wheel assembly. She did not sustain any injuries and did not receive any medical treatment.

Front Right Passenger

Age/Sex:	16-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Appeared to be in the mid-track position in on-scene photographs
Manual Restraint Use:	Unrestrained
Usage Source:	Police report
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a local hospital, but her admission status was not reported

Front Right Passenger Kinematics

The 16-year-old female front right passenger was presumed to be seated in an upright posture with the seat track adjusted to the mid-track position. She was not restrained by the available manual 3-point lap and shoulder belt. The unrestrained 6-year-old male was seated on her lap. Pre-crash braking displaced both occupants forward. The 6-year-old was displaced into the path of the front right passenger's air bag. At impact, the frontal air bag system deployed and both occupants initiated forward trajectories. The 6-year-old prevented the front right passenger from contacting the front right passenger's air bag. The child probably rebounded rearward into the front right passenger. The 16-year-old sustained police reported

incapacitating injuries, possibly from occupant-to-occupant contact, however, the nature and extent of the injuries were not known. She was transported to a local hospital, but her admission status was not reported.

Front Right Child Passenger (on lap)

Age/Sex:	6-year-old male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	On-lap of the front right passenger
Manual Restraint Use:	Unrestrained
Usage Source:	Injury data, police report
Eyewear:	Unknown
Type of Medical Treatment:	Transported to a local hospital and pronounced dead on arrival

Front Right Child Passenger (on lap) Injuries

Injury	Injury Severity (AIS 90/Update 98)	Possible Injury Mechanism
Cervical dislocation*	Moderate (650204.2,6)	Front right passenger's air bag expansion

Injury source: Coroner's report

*Although not medically diagnosed, the child passenger probably sustained a spinal cord or brain stem injury that contributed to his death. Cervical dislocation alone does not result in death.

Front Right Child Passenger (on lap) Kinematics

The only available injury data for the child passenger consisted of a coroner's report. The coroner's report only stated the cause of death, which was cervical dislocation. Due to the limited injury data, the kinematic patterns could not be confirmed.

The 6-year-old male child was seated on the lap of the front right passenger and was assumed to have been seated in an upright posture. He was displaced forward into the path of the front right passenger's air bag by pre-crash braking. He may have been positioned over the module cover flap. At impact, the frontal air bag system deployed. The child was probably struck by the deploying air bag under the chin and against the chest. The vertical expansion against the underside of the chin combined with the rearward expansion against his chest and the front right passenger's forward displacement against him resulted in a cervical spine dislocation. He was redirected rearward and most likely struck the front right passenger. It was not known how he exited the vehicle. He was transported to a local hospital where he was pronounced dead on arrival.

Rear Seat Child Passenger Kinematics

The rear seated child passengers were presumed to be seated in an upright posture. The 16-year-old male rear left passenger and 7-year-old rear center passenger were not restrained by the manual belt systems. The 2-year-old male was seated in a forward facing child safety seat which was installed with the manual 3-point lap and shoulder belt in the rear right position. The child seat might not have been tightly secured, as the manual restraint was not equipped with a switchable retractor and there was no locking clip installed on the seat belt webbing. It was not known if the 2-year-old was properly restrained in the child safety seat. Pre-crash braking probably displaced the rear seated occupants forward. At impact, they initiated forward trajectories. The 16-year-old probably loaded the driver's seat back and 7-year-old probably loaded the center console and the driver's and/or front right passenger's seat back. The children seated in the rear seat did not sustain injuries, but the 2-year-old was transported to a local hospital. His admission status was not reported.