CRASH DATA RESEARCH CENTER

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CALSPAN REMOTE ADULT AIR BAG RELATED SERIOUS INJURY CRASH INVESTIGATION

NASS/SCI CASE NO: 2005-48-020C

VEHICLE: 2005 NISSAN ALTIMA

LOCATION: ALABAMA

CRASH DATE: FEBRUARY 2005

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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 the injury sources to a 45-year old restrained female driver of a 2005 Nissan Altima. The Nissan was equipped with an Advanced Occupant Protection System (AOPS) that consisted of dual stage frontal air bags and front safety belt pretensioners. The Nissan was involved in a moderate severity crash with a pine tree. The vehicle departed the roadway and descended down a slope where it bottomed out as the roadside leveled and then continued along its trajectory to a frontal impact with the tree. The impact was sufficient to deploy the frontal air bags and actuate the pretensioners. The Nissan's 45 year old driver sustained serious thoracic injuries as a result of the crash. Her injuries consisted of an AIS 3 right lung contusion, right rib fractures and a chest abrasion as a result of loading the driver's air bag and manual shoulder belt. The driver was transported to a regional trauma center where she was hospitalized overnight and then released.			
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BACKGROUND

This remote investigation focused on the injury sources to a 45-year old restrained female driver of a 2005 Nissan Altima **(Figure 1)**. The Nissan was equipped with an Advanced Occupant Protection System (AOPS) that consisted of dual stage frontal air bags and front safety belt pretensioners. The Nissan was involved in a moderate severity crash with a pine tree. The vehicle departed the roadway and descended down a slope where it bottomed out as the roadside leveled, and then continued along its trajectory to a frontal impact with the tree. The impact was sufficient to deploy the frontal air bags and actuate the pretensioners. The Nissan's 45 year old driver sustained serious thoracic injuries as a result of the crash. Her injuries consisted of an AIS 3 right lung contusion, right rib fractures, and a chest abrasion as a result of loading the driver's air bag and manual shoulder belt. The driver was transported to a regional trauma center where she was hospitalized overnight and then released.


Figure 1 - Damaged 2005 Nissan Altima.

This crash was selected for investigation as case number 2005-48-020C by the National Automotive Sampling System (NASS) within their weekly sampling activities. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) subsequently assigned a remote combined NASS/SCI investigation to the Calspan Special Crash Investigations team on October 14, 2005 due to the driver's air bag related serious injuries. It should be noted that only the 2005 Nissan Altima vehicles manufactured after September 2004 are Certified Advanced 208-Compliant (CAC) vehicles. The NASS field investigation determined that the subject vehicle was <u>not</u> a CAC vehicle due its March 2004 date of manufacture.

SUMMARY

Crash Site

This crash occurred on a two-lane, east/west roadway in a rural area in February 2005. At the time of the crash, it was nighttime and there was no artificial lighting. The asphalt roadway was configured with one lane in each direction and without markings. Bordering the roadway to the north was a steep downward slope along with natural growth. The slope was approximately 3 meters (10') in height and began to level approximately 15 meters (50') north of the roadway. The south roadside consisted of natural growth and sporadic dwellings. At the time of the crash, the road surface was dry and there were no adverse weather conditions. The roadway was curved left for

westbound travel. The speed limit for the level roadway was posted at 48 km/h (30 mph). The SCI-revised scene schematic is included as **Figure 10** at the end of this narrative report.*

Vehicle Data

2005 Nissan Altima

The subject vehicle in this single-vehicle crash was a 2005 Nissan Altima four-door sedan. The Altima was manufactured in 03/04 and was identified by Vehicle Identification Number (VIN): 1N4AL11D15C (production number omitted). The total GVWR was 1,906 kg (4,201 lbs) which distributed 1,020 kg (2,248 lbs) to the front and 893 kg (1,968) to the rear. The Altima was equipped with a 4-cylinder, 2.5-liter engine linked to a 4-speed automatic transmission. The braking system consisted of 4-wheel disc brakes. The front-wheel drive vehicle was configured with 41 cm (16") steel wheels and was outfitted with Continental Touring Contac AS P215/60R16 tires. The vehicle manufacturer's recommended tire pressure was 200 kPa (29 PSI) front and rear. The specific tire data at the time of the NASS inspection was as follows:

Position	Tire Pressure	Tread Depth	Damage
LF	241 kPa (35 PSI)	9 mm (11/32")	None
RF	207 kPa (30 PSI)	10 mm (13/32")	None
LR	241 kPa (35 PSI)	9 mm (11/32")	None
RR	207 kPa (30 PSI)	10 mm (13/32")	None

The 2005 Nissan Altima was configured with front bucket seats with adjustable head restraints. The front seats were adjusted to a track position between the middle and rear seat track. The second row consisted of a fixed bench seat with integral head restraints for the outboard seating positions. All five seating positions were equipped with manual 3-point lap and shoulder belts. The front seats have retractor pretensioners that actuated during the impact.

Crash Sequence

Pre-Crash

The 45-year old female driver of the 2005 Nissan Altima was traveling westbound on the two-lane roadway and was negotiating a sharp left curve **(Figure 2)**. As the vehicle was negotiating the curve, it drifted off the right roadside and down a slope approximately 3 m (10') in height **(Figure 3)**. There was no pre-crash evidence of braking or attempted avoidance maneuvers.

Figure 2 - Westbound approach of Nissan Altima.

Figure 3 - Slope leading to point of impact.

Crash

The Nissan traveled in a northwesterly direction approximately 25 meters (75') descending down the slope until it bottomed out as the roadside environment leveled **(Figure 4)**. The front aspect of the undercarriage struck the ground in a non-horizontal configuration. The vehicle continued tracking in a northwesterly direction on the wooded roadside an additional 5 meters (15') before striking a large pine tree of an unreported diameter with its front right corner **(Figure 5)**. The direction of force for the impact with the tree was 12 o'clock. An SCI revised damage algorithm of the WinSMASH program computed a total delta-V of 27 km/h (16.8 mph). The specific longitudinal and lateral velocity change was -27 km/h (-16.8 mph) and 0 km/h, respectively. Following the impact, the Nissan rotated clockwise around the tree approximately 90 degrees and came to rest facing in a northerly direction. The impact deployed the frontal air bag system and actuated the pretensioners in the Nissan.

Figure 4 - Foot of slope; area of undercarriage impact.

Figure 5 - Point of impact with pine tree.

Post-Crash

The driver was able to exit the vehicle under her own power through the front left door. Emergency personnel arrived on scene and the driver was transported to a regional trauma center where she was admitted overnight. She was treated for multiple fractured ribs and right lung contusion and was then released. The vehicle was towed from the scene due to structural damage.

2005 Nissan Altima

Exterior

Figure 6 - Damaged frontal plane on 2005 Nissan Altima.

The 2005 Nissan Altima sustained moderate damage as a result of the impact with the pine tree **(Figure 6)**. The direct contact damage began at the right front bumper corner and measured an SCI revised 51 cm (20") in length.* The combined direct and induced damage encompassed the width of the front bumper and measured 160 cm (63"). The NASS investigation revealed that the maximum crush was located 33 cm (13") right of the vehicle's centerline and measured 34 cm (13.4") in depth. The damage profile was measured to the bumper beam and was adjusted for the missing bumper cover and energy absorption material. The crush profile consisted of six equidistant crush measurements that were as follows: C1 = 0 cm, C2 = 6 cm (2.4"), C3 = 17 cm (6.7"), C4 = 25 cm (9.8"), C5 = 34 cm (13.4"), C6 = 23 cm (9.1"). The SCI revised Collision Deformation Classification (CDC) was 12-FREW-2.*

The Altima sustained only minor undercarriage damage from the non-horizontal impact to the ground. The damage consisted primarily of surface scratching and was absent of any residual crush. The NASS vehicle inspection did not reveal any specific damage measurements for this event. The SCI revised CDC for this impact was 00-UFDW-1.*

Interior

The interior of the 2005 Nissan Altima sustained minor damage as a result of occupant contact to interior components. A small scuff was present under and to the left of the steering assembly. There was no passenger compartment intrusion. The windshield was cracked from impact forces; there was no damage to the remaining glazing and the doors remained closed and operational. The vehicle was equipped with a tilt steering wheel and it was adjusted to the full-up position at the time of the NASS inspection.

Manual Restraints

Figure 7 - Transfer evidence on shoulder belt.

The 2005 Nissan Altima was configured with manual 3-point lap and shoulder belts and sliding latch plates for all five seating positions. The driver's belt exhibited loading evidence in the form of minor scuffing and stretching on the webbing indicating that the restraint was in use during the crash **(Figure 7)**. The driver's seat was equipped with an Emergency Locking Retractor (ELR), a retractor pretensioner, and an adjustable D-ring, which was in the full-up position. The front right seat was equipped with a retractor pretensioner and adjustable D-ring, which was in the full-up position. The

type of retractor for the front right belt could not be determined due to firing of the pretensioner. The rear seat restraints were equipped with switchable ELR/Automatic Locking Retractors (ALR's), which were in the ELR mode. The rear seat was also equipped with a Lower Anchors and Tethers for Children (LATCH) system for all three seating positions.

Frontal Air Bag System

The 1995 Nissan Altima was equipped with dual-stage frontal air bags for the driver and front right seating positions. The driver's air bag was housed in the center of the steering wheel hub **(Figure 8)**. The driver's air bag deployed through trapezoidal-shaped cover flaps. The upper flap measured 14 cm (5.5") in width and 5 cm (2") in height. The top aspect of the lower flap was 13 cm (5.1") in width and the lower aspect was 10 cm (3.9") in width. The lower flap was 7 cm (2.8") in height. The driver's air bag measured 60 cm (23.6") in diameter in its deflated state. The air bag was vented by two circular ports located in the 11 and 1 o'clock positions on the back aspect of the air bag. The air bag was not tethered. It should be noted that the steering wheel was rotated 180 degrees at the time of the NASS inspection.

Loading evidence in the form of three red clothing transfers were identified evenly distributed along the top aspect of the air bag membrane. Based on a review of images, the transfers were approximately 2 cm (0.8") in length. The first transfer was located 20 cm (7.9") inboard of the outer left edge and 15 cm (5.9") below the top edge of the deployed air bag. The second transfer straddled the mid-line of the air bag 13 cm (5.1") below the top edge. The third transfer was located 17 cm (6.7") inboard of the right outer edge and 15 cm (5.9") below the top edge of the air bag.

The front right air bag deployed from a top-mount module configured with a single rectangular vinyl cover flap hinged at the top aspect **(Figure 9)**. The cover flap measured 28 cm in width and 6 cm (2.4") in height. The air bag measured 60 cm (23.6") in height and 65 cm (25.6") in width in its deflated state. The air bag was vented by two circular ports located in the 3 and 9 o'clock positions. The air bag was not tethered and no loading evidence was identified on the air bag membrane.

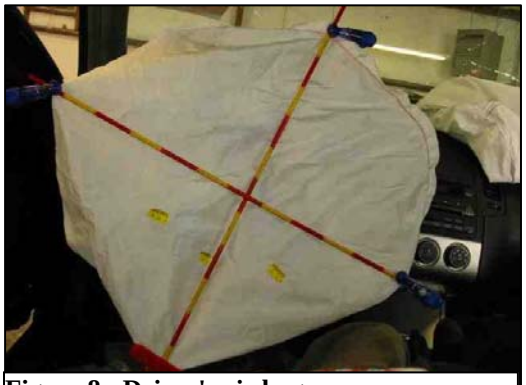

Figure 8 - Driver's air bag.

Figure 9 - Front right air bag.

Occupant Demographics

Driver

Age/Sex:	45-year old/Female
Height:	170 cm (67")
Weight:	65 kg (143 lbs)
Seat Track Position:	Between mid track and full-rear
Manual Restraint Usage:	3-point lap and shoulder belt
Usage Source:	NASS vehicle inspection
Eyewear:	None
Type of Medical Treatment:	Transported to a regional trauma center where she was hospitalized for one day.

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Right lung contusion	Serious (441406.3,1)	Expanding driver's air bag
Multiple rib fractures (4-6) to right anterior cage	Moderate (450220.1,1)	Expanding driver's air bag
Rib fractures (8-9) to right anterior cage.	Moderate (450220.2,1) *	Shoulder restraint
Chest abrasion	Minor (490202.1,1)	Expanding driver's air bag
3 cm abrasion on the anterior aspect of the right wrist **	Minor (790202.1,1)	Expanding driver's air bag
Contusion of the left shoulder to mid chest **	Minor (490402.1,2)	Shoulder restraint

Source: The lung contusion, rib fractures and chest abrasion were identified by Medical Records.
*** The wrist abrasion and chest contusion were identified by NASS interview and added during the SCI case review.*

Driver Kinematics

The restrained 45-year old driver was seated in an upright posture as her vehicle departed the right roadside. As the vehicle bottomed out at the foot of the slope, the driver initiated a forward and descending trajectory and loaded her 3-point manual lap and shoulder restraint. The driver sustained fractures to her anterior rib cage (8-9) from loading the shoulder portion of the safety belt, evidenced by the loading marks on the belt. As the vehicle impacted the pine tree, the frontal air bags and retractor pretensioners actuated. The driver sustained additional fractures to the right anterior rib cage (4-6), a right lung contusion, and a chest abrasion as a result of the expanding driver's air bag. Supporting this, three distinct clothing transfers were identified on the deployed air bag membrane. The kinematic pattern positioned the driver forward and in close proximity to the driver's air bag module. The driver was able to exit the vehicle under her own power following the crash. Emergency personnel arrived on the scene and transported the driver to a regional trauma center where she was hospitalized overnight.

*Denotes that the original NASS coded information was revised by SCI for this narrative.

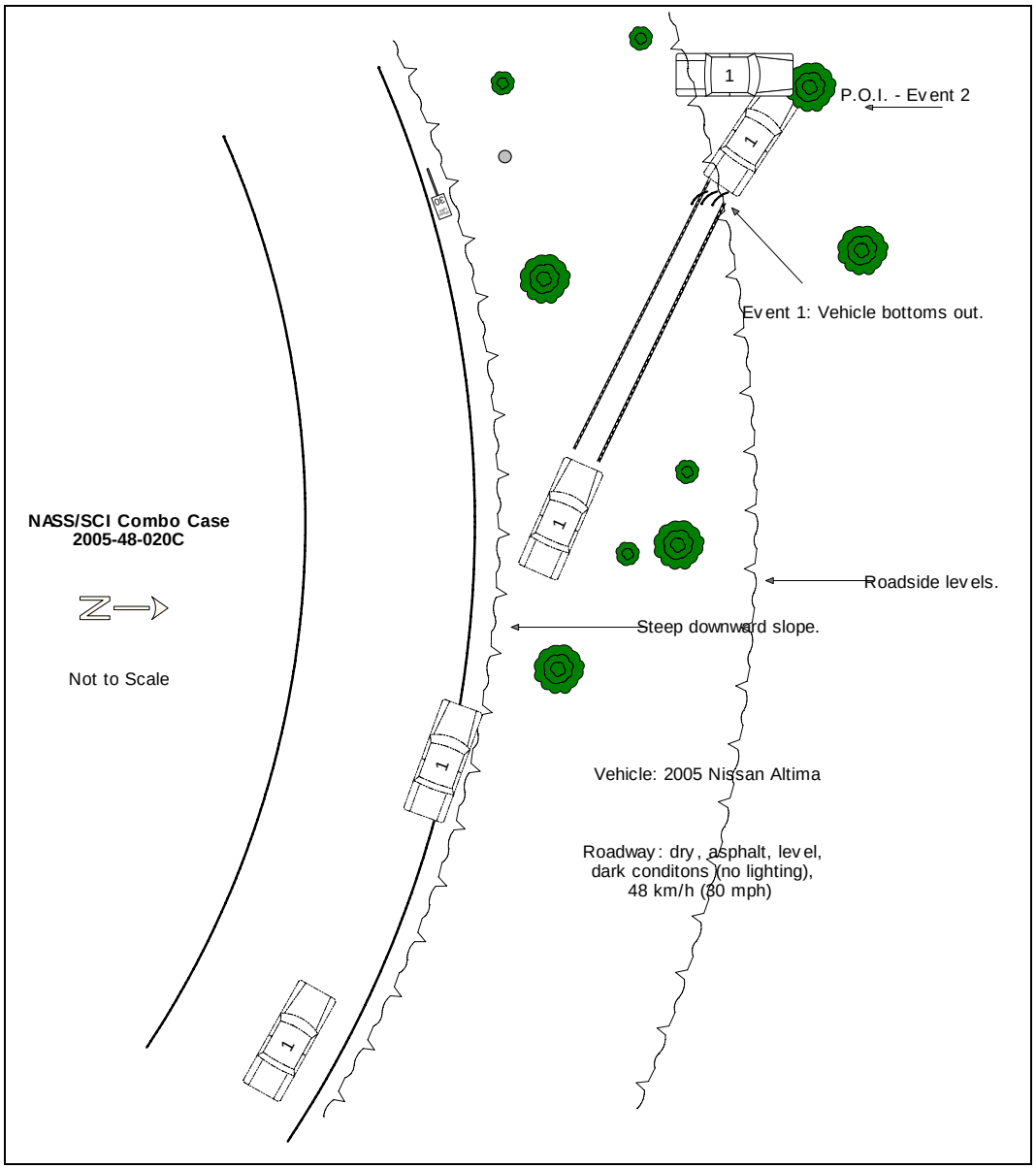

Figure 10 - SCI Revised Scene Schematic.