TRANSPORTATION SCIENCES
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CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION

CALSPAN CASE NO: CA05-027

VEHICLE: 2005 NISSAN ALTIMA

LOCATION: VIRGINIA

CRASH DATE: MARCH 2005

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. CA05-027	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Certified Advanced 208-Compliant Vehicle Crash Investigation Vehicle: 2005 Nissan Altima Location: State of Virginia		*5. Report Date*: January 2006 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Transportation Sciences Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0289 *11. Contract or Grant No.* DTNH22-01-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: December 2004 *14. Sponsoring Agency Code*	
15. Supplementary Note On-site investigation focused on the performance of the Certified Advanced 208-Compliant safety system in a 2005 Nissan Altima.			
16. Abstract This on-site investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system in a 2005 Nissan Altima. The manufacturer of this vehicle has certified that this 2005 Nissan Altima meets the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC safety system consisted of dual stage frontal air bags, an occupant presence sensor for the front right seat, and safety belt buckle switch sensors to monitor belt usage. In addition, the Nissan was equipped with an air bag control module, which had Event Data Recording (EDR) capabilities and was downloaded during this on-site investigative effort. An unrestrained 22-year-old male driver occupied the vehicle. The Nissan was involved in a run-off road collision where it impacted two guardrails. As a result of the crash, the driver's frontal air bag deployed and the front safety belt retractor pretensioners fired. The driver of the Nissan was not injured and refused medical attention. The vehicle sustained moderate frontal damage and was towed from the crash site.			
17. Key Words Driver's Frontal Air Bag Deployment Certified Advanced 208-Compliant Safety System		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 9	*22. Price*

TABLE OF CONTENTS

CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION
SCI CASE NO. – CA05-027
SUBJECT VEHICLE – 2005 NISSAN ALTIMA
LOCATION - STATE OF VIRGINIA
CRASH DATE – MARCH 2005

BACKGROUND

This on-site investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system in a 2005 Nissan Altima **(Figure 1)**. The manufacturer of this vehicle has certified that this 2005 Nissan Altima meets the advanced air bag requirements of the Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC safety system consisted of dual stage frontal air bags, an occupant presence sensor for the front right seat, and safety belt buckle switch sensors to monitor belt usage. In addition, the Nissan was equipped with an air bag control module, which had Event Data Recording (EDR) capabilities and was downloaded during this on-site investigative effort. An unrestrained 22-year-old male driver occupied the vehicle. The Nissan was involved in a run-off road collision where it impacted two guardrails. As a result of the crash, the driver's frontal air bag deployed and the front safety belt retractor pretensioners fired. The driver of the Nissan was not injured and refused medical attention. The vehicle sustained moderate frontal damage and was towed from the crash site.

Figure 1. Subject vehicle 2005 Nissan Altima.

This crash was identified from a list of claims provided by an insurance company to the National Highway Traffic Safety Administration (NHTSA) that identified Certified Advanced 208-Compliant vehicles that had been involved in crashes. The list was forwarded to the Calspan Special Crash Investigations (SCI) team for follow-up investigation. The Nissan was located at a salvage facility and cooperation was established with the facility to inspect the vehicle. An on-site investigation was assigned to the Calspan SCI team on April 27, 2005. The vehicle was inspected on April 29, 2005. The driver provided minimal data as he refused a detailed interview.

SUMMARY

Crash Site

This run-off crash occurred during the nighttime hours of March 2005. At the time of the crash, the weather was clear and the roadway was dry. The crash occurred on a single lane on-ramp to an east/west interstate. The ramp curved left as it approached the interstate and was bordered by W-beam guardrail longitudinal barriers. At the time of the investigation, the Police Accident Report was not available. Therefore, the crash site was not inspected during this on-site investigation. A scene schematic that was derived from the police report is included as **Figure 10** of this report.

Vehicle Data – 2005 Nissan Altima

The 2005 Nissan Altima was identified by the Vehicle Identification Number (VIN): 1N4AL11D05 (production sequence deleted). The odometer was not functional at the time of the SCI inspection. The Nissan was a four-door sedan that was equipped with a 2.5-liter, four-cylinder engine linked to a 4-speed automatic transmission, front-wheel drive, power-front and rear disc brakes, power steering, and a tilt steering wheel. The Nissan was configured with Continental Touring Contact AS tires, size P215/60R16 mounted on OEM alloy wheels. The manufacturer recommended front and rear tire pressure was 241 kPa (35 PSI). The specific tire data at the time of the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	0 kPa	10 mm (12/32)	No	Fractures to inner and outer alloy rim
LR	200 kPa (29 PSI)	10 mm (12/32)	No	No
RF	200 kPa (29 PSI)	9 mm (11/32)	Yes	No
RR	200 kPa (29 PSI)	10 mm (12/32)	No	No

The seating positions in the Nissan were configured with cloth upholstered front buckets seats with height adjustable head restraints. The front head restraints were adjusted to the full-down position and the time of the SCI inspection. The second row was configured with a three-passenger bench seat with a 60/40 split, and integrated head restraints for the outboard seating positions.

Crash Sequence

Pre-Crash

The unrestrained 22-year-old male driver of the 2005 Nissan Altima was operating the vehicle northbound on a single lane on-ramp to an interstate. As the driver continued the northbound travel, he departed the right road edge. The vehicle traversed the paved shoulder in a presumed tracking mode.

Crash

The front right corner of the Nissan impacted the W-beam guardrail. The initial contact redirected the vehicle to its left, which resulted in continuous sideswipe damage to the right side of the Nissan. The resultant direction of force for this impact was within the 12 o'clock sector. The damaged frontal components were removed from the vehicle prior to the SCI inspection. This, in combination with the sideswipe engagement negated a WINSMASH reconstruction of this event.

As a result of the initial impact, the driver of the Nissan applied a left steering input. The steering input induced a counterclockwise (CCW) yaw as the Nissan traversed the travel lane. The vehicle departed the left roadside where the front of the Nissan impacted the left side W-beam guardrail. This impact redirected the vehicle in a northeast trajectory, which allowed the left tire to engage a mounting post for the guardrail. This engagement fractured the left front wheel and displaced the axle 15 cm (5.7") rearward. The left side guardrail impact redirected the vehicle to the right as the center gravity (CG) continued forward. The Nissan came to final rest near the guardrail facing a northeast direction.

Based on the resultant damage, the direction of force was within the 1 o'clock sector. The barrier equivalent algorithm of the WINSMASH calculated a total delta-V of 12.0 km/h (7.5 mph) for this event. The longitudinal and lateral components were -11.3 km/h (-7.0 mph) and -4.1 km/h (-2.6 mph), respectively. As a result of the crash, the driver's frontal air bag deployed and both front safety belt retractor pretensioners fired. The EDR data indicated that a stage one deployment was commanded of the driver's frontal air bag at 85 milliseconds after algorithm enable.

Post-Crash

Police and Emergency Medical Services (EMS) personnel responded to the crash site. The driver of the Nissan was not injured and refused medical attention. The Nissan sustained disabling damage and was towed from the crash site and was subsequently deemed a total loss by the insurance company.

Vehicle Damage

Exterior Damage

The 2005 Nissan Altima sustained minor severity damage to the front and right side planes from initial guardrail impact **(Figures 2 and 3)**. At impact, the right bumper fascia fractured and separated from the vehicle. The bumper fascia was found fractured into four separate pieces at the time of the SCI inspection. The right corner of the fascia exhibited damage from contacting the pavement, which resulted in an abrasion pattern that overlapped the guardrail direct contact damage. Additionally, the bumper beam was removed from the vehicle. The frontal direct damage could not be determined due to the separation and removal of the frontal components. Therefore, the right side sideswipe damage was documented for this event. The direct contact damage began at the front right corner and extended 422 cm (166.5") rearward. The maximum crush measured 8 cm (3.3") and was located on the forward aspect of the right front fender. Six equidistant crush measurements were document at the mid-door level using a combined direct and induced damage length of 422 cm (166.5") and were as follows: C1 = 0 cm, C2 = 1 cm (0.5"), C3 = 2 cm (0.8"), C4 = 3 cm (1.3"), C5 = 3 cm (1.3"), C6 = 8 cm (3.3"). The Collision Deformation Classification (CDC) for this impact was 12-FRES-9.

Figure 2. Right sideswipe damage from the initial guardrail impact.

Figure 3. Front right damage from the initial guardrail impact.

The vehicle sustained moderate damage to the front plane as result of the impact with the left side guardrail **(Figure 4)**. The direct contact damage began 35 cm (12.0") left of the centerline and extended left 47 cm (18.5") to the left corner. The maximum crush was 12 cm (4.7") located at the left frame rail. Furthermore, the left wheel engaged the guardrail, which fractured the left front wheel and reduced the left wheelbase 15 cm (5.7"). A crush profile was documented across the lower radiator support using a combined direct and induced damage width of 94 cm (37.0")

Figure 4. Frontal damage from the second guardrail impact.

which was as follows: C1 = 12 cm (4.7”), C2 = 4 cm (1.6”), C3 = 0 cm, C4 = 0 cm, C5 = 0 cm, C6 = 3 cm (1.2”). The CDC from this impact was 01-FLEW-1.

Interior Damage

The 2005 Nissan Altima sustained minor interior damage as a result of the air bag deployment and occupant contact points. The driver’s occupant contact points consisted of an oily transfer to the rear view mirror from contact with the driver’s head **(Figure 5)**. The stalk of the rear view mirror was deflected to the right. Additionally, the contact to the rear view mirror resulted in fractures to the center of the windshield at the mounting point for the mirror. The driver’s right thigh contacted the center console, which dislodged the trim panel and displaced it to the right **(Figure 6)**. The center console mounted emergency brake lever was deflected to the right approximately 2 cm (0.8”) from contact with the driver’s right hip.

Figure 5. Rear view mirror contact point.

Figure 6. Center console and emergency brake lever contact points.

Certified Advanced 208-Compliant Safety System

The 2005 Nissan Altima was equipped with a Certified Advanced 208-Compliant (CAC) frontal safety system. The manufacturer of this vehicle has certified that this 2005 Nissan Altima meets the advanced air bag requirements of FMVSS No. 208. The system consisted of dual stage frontal air bags, an occupant presence sensor for the front right seat, and safety belt buckle switch sensors to monitor belt usage.

In the subject crash, the driver’s frontal air bag deployed. The driver’s air bag was conventionally located in the center of the steering wheel hub **(Figure 7)**. Two cover flaps concealed the air bag. The upper and lower cover flaps measured 13 cm (5.3”) in width at the tear seam. The upper cover flap measured 5 cm (1.8”) in height and the lower flap measured 9 cm (3.4”) in height. The air bag membrane was 53 cm (21.0”) in diameter in its deflated state. Two 3 cm

Figure 7. Deployed driver's frontal air bag.

(1.0”) diameter vent ports that were surrounded by 8 cm (3.0”) stitch patterns were located on the rear aspect of the air bag at the 10 and 2 o’clock positions. The air bag was tethered by four 7 cm (2.8”) wide tethers at the 12 and 6 o’clock positions and the 9 and 3 o’clock positions. There were no occupant contact points present on the air bag membrane.

The front right passenger air bag was a top-mount design in the right instrument panel. The front right seat was not occupied during the crash, therefore the front right air bag did not deploy.

Event Data Recorder (EDR)

The CAC system was controlled by an air bag control module, which utilized the crash severity, belted status, and occupant presence to deploy the appropriate safety systems. In addition, the air bag control module had EDR capabilities and was downloaded during this on-site investigation. The vehicle battery was discharged; therefore the SCI investigator temporarily restored power to the Nissan using an external battery pack. The SCI investigator downloaded the EDR through the Diagnostic Link Connector (DLC) using the Nissan Consult II scan tool, which was provided by Nissan. This tool prints out a data tape of the hexadecimal data, which was forwarded to Nissan for interpretation. The Nissan provided data indicated that the safing sensor closed at 11 milliseconds after Algorithm Enable (AE) and commanded a Stage One deployment of the driver air bag at 85 milliseconds after AE. Delta-V data was not recorded by the EDR. Additionally, the EDR indicated that the driver’s safety belt was not buckled and the front right seat was not occupied at the time of the crash; however, both front retractor pretensioners fired.

Manual Restraint Systems

The 2005 Nissan Altima was equipped with manual 3-point lap and shoulder safety belts for the five seating positions. The driver’s safety belt was configured with continuous loop webbing, sliding latch plate, height adjustable D-ring that was in the full-up position at the time of the inspection, retractor-mounted pretensioner, and an Emergency Locking Retractor (ELR). The driver did not utilize the safety belt during the crash. The retractor pretensioner fired which spooled-up the slack and locked the safety belt taut against the B-pillar in the stowed position.

The front right safety belt was configured with continuous loop webbing, sliding latch plate, height adjustable D-ring that was in the full-down position at the time of the inspection, retractor-mounted pretensioner, and a switchable ELR/Automatic Locking Retractor (ALR). Although the front right position was not occupied, the front right retractor pretensioner fired, which locked the webbing in the stowed position. The second row safety belts were configured with continuous loop webbing, sliding latch plates and switchable ELR/ALR.

Active Head Restraints

The 2005 Nissan Altima was equipped with Active Head Restraints (AHR) for the front seating positions. The AHR's were designed to move forward in the event of a rear-end collision. The Nissan did not sustain a rear-end collision therefore the AHR's were not activated. **Figures 8 and 9** are of the driver AHR and label.

Figure 8. Driver's Active Head Restraint.

Figure 9. Active Head Restraint label.

Occupant Demographics

Driver

Age/Sex:	22-year-old/Male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Rear track
Manual Restraint Use:	None Used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Not injured

Driver Kinematics

The 22-year old male driver of the Nissan Altima was seated in a presumed upright posture with the seat track adjusted to a rear track position. The adjustable head restraint was in the full down position. The driver was not restrained by the manual safety belt system. The lack of belt usage was supported by his trajectory, occupant contact points and the locked position of the safety belt webbing in its stowed position due to the firing of the retractor pretensioner.

As the Nissan engaged the first guardrail system, the driver responded to the frontal impact force by initiating a forward trajectory. The severity of the crash was rated as minor; therefore the driver had minimal contact, if any with frontal components.

He rebounded into the seat back as the vehicle traversed the ramp and departed the left roadside in a slight counterclockwise yaw. The left frontal area of the vehicle impacted the left side guardrail resulting in a 1 o'clock direction of force. Although not supported

by EDR data, this event probably resulted in the deployment of the driver's air bag and the firing of the front safety belt retractor pretensioners.

The unrestrained driver initiated a forward and lateral trajectory to his right as he responded to the 1 o'clock impact force. His right thigh and hip contacted the center console and emergency brake lever respectively. Although he was not injured by this contact sequence, his loading deflected these components to the right.

The driver partially loaded the right side of the air bag as he continued forward. His head contacted the rear view mirror and deflected the mirror to the right and compressed the mirror against the laminated windshield. The windshield fractured from the mirror contact. A skin oil transfer was noted to the mirror glass.

The driver rebounded from this contact into the front right seat back where he came to rest. He was not injured and refused medical attention.

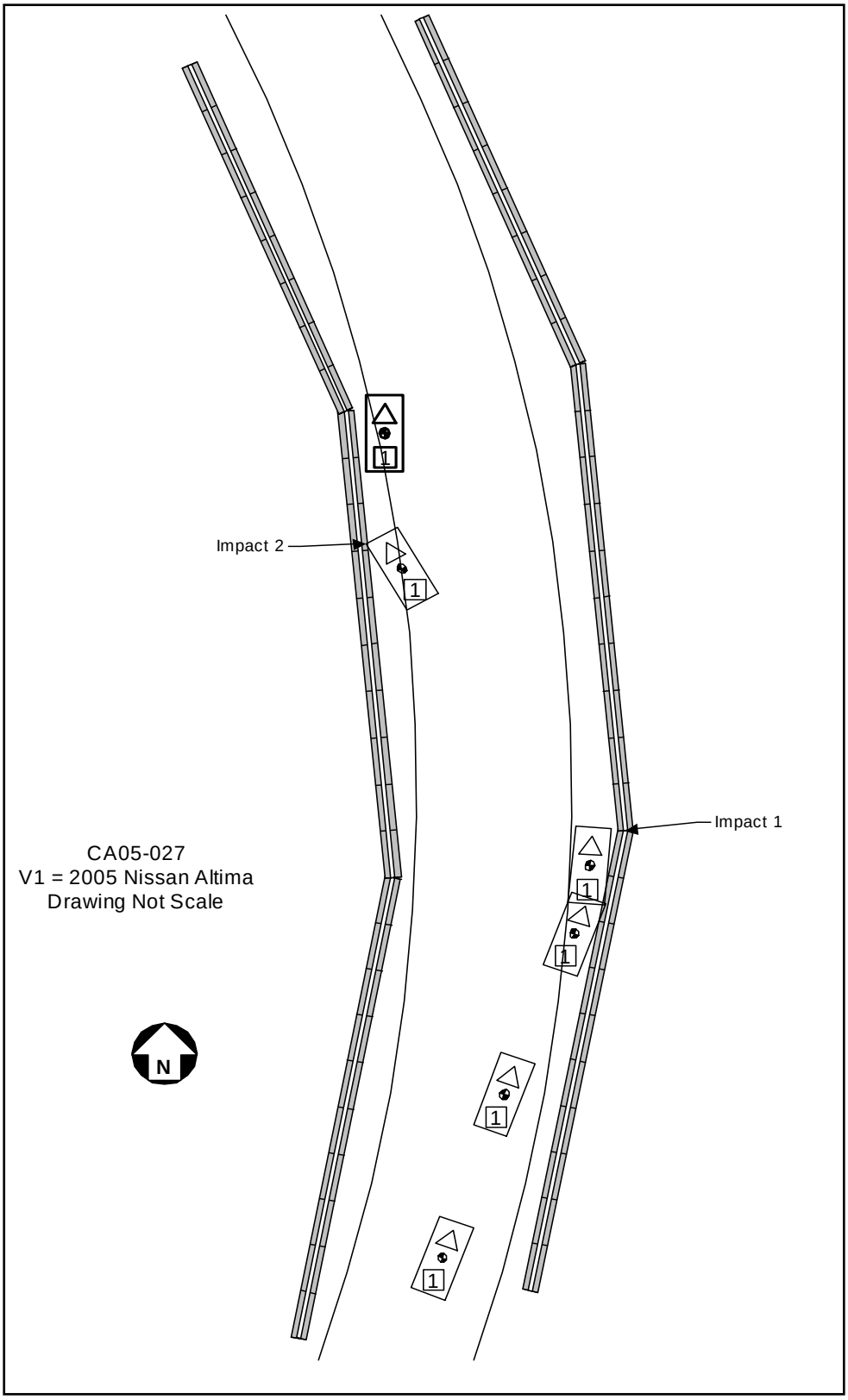

Figure 10. Scene schematic