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**CALSPAN ON-SITE ADVANCED OCCUPANT PROTECTION  
SYSTEM CRASH INVESTIGATION  
SCI CASE NO: CA04-028**

**VEHICLE: 2004 NISSAN PATHFINDER  
LOCATION: NORTH CAROLINA**

**CRASH DATE: MAY 2004**

Contract No. DTNH22-01-C-17002

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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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<i>16. Abstract</i> This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) in a 2004 Nissan Pathfinder. The Nissan was involved in a road side departure and a severe frontal impact with a 99 cm (39 in) diameter tree. The Nissan Pathfinder was equipped with an AOPS that consisted of advanced dual stage frontal air bags, front seat belt retractor pretensioners, and front seat belt buckle switch sensors. The Nissan was also equipped with the optional side impact air bags that consisted of front seat back mounted thorax bags and inflatable side curtains. The 16 year old male driver suffered facial abrasions, safety belt related abdominal abrasions, a left lower extremity contusion, and fractures of the right third and fourth metacarpals in the crash. He was transported to a regional trauma center and hospitalized for two days.			
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***BACKGROUND***

This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) in a 2004 Nissan Pathfinder, **Figure 1**. The Nissan was involved in a road side departure and a severe frontal impact with a 99 cm (39 in) diameter tree. The Nissan Pathfinder was equipped with an AOPS that consisted of advanced dual stage frontal air bags, front seat belt retractor pretensioners, and front seat belt buckle switch sensors. The Nissan was also equipped with the optional side impact air bags that consisted of front seat back mounted thorax bags and inflatable side curtains. The 16 year old male driver suffered facial abrasions, safety belt related abdominal abrasions, a left lower extremity contusion, and fractures of the right third and fourth metacarpals in the crash. He was transported to a regional trauma center and hospitalized for two days.



**Figure 1: Front left oblique view.**

This crash was identified from a list of total loss claims provided by an insurance company to the National Highway Traffic Safety Administration. (NHTSA). The list identified vehicles with advanced air bag systems that had been involved in crashes. NHTSA forwarded a list of these vehicles to the Calspan Special Crash Investigations team for follow-up investigation. The Nissan was located at an insurance salvage yard and was available for inspection. The vehicle was inspected July 10, 2004.

***SUMMARY***

***VEHICLE DATA***

The 2004 Nissan Pathfinder was identified by the Vehicle Identification Number (VIN): JN8DR09Y94W (production sequence deleted). The four-wheel drive, four door sport utility vehicle was equipped with the LE level trim. The power train consisted of a 3.5 liter V6 engine linked to a four-speed automatic transmission with overdrive. The service brakes were front disc/rear drum system with rear wheel ABS. The vehicle's date of manufacture was October 2003. The electronic digital odometer was inoperative at the time of the inspection due to the collision damage. The Pathfinder was configured for five passenger seating. The four outboard seat positions were equipped with a manual restraint system that consisted of continuous loop lap and shoulder belts with sliding latch plates. The front restraints were equipped with retractor pretensioners with belt force limiting features. The vehicle was equipped with dual stage frontal

air bags, front seat back mounted side impact air bags and inflatable side curtains. The Pathfinder was equipped with Bridgestone Dueler HT P245/65R17 tires on OEM alloy wheels. The recommended tire pressure was 207 kPa (30 PSI). The specific measured tire data was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	241 kPa (35 PSI)	10 mm (12/32 in)	No	None
LR	183 kPa (26 PSI)	10 mm (12/32 in)	No	None
RF	234 kPa (34 PSI)	10 mm (12/32 in)	No	None
RR	227 kPa (33 PSI)	10 mm (12/32 in)	No	None

**CRASH SITE**

This single vehicle crash occurred during the afternoon hours in May 2004. At the time of the crash, it was daylight and the weather was not a factor. The crash occurred on a two lane north/south road in a rural setting. At the crash site, there was a left curve for northbound traffic. The radius of the curve measured 579 m (1900 ft). There was a 9 percent negative grade in the northbound direction. The respective travel lanes were separated by solid double yellow lines. The 3.2 m (10.5 ft) traffic lanes were bordered by white fog lines and narrow 0.4 m (1.5 ft) wide shoulders. A 0.3 m (1.0 ft) deep ditch ran parallel to the east road edge and was centered 1.4 m (4.0 ft) east of the pavement edge. East of the ditch, the elevation of the terrain along back slope of the ditch increased 0.7 m (2.3 ft) over a lateral dimension of 1.5 m (5.0 ft) and then leveled. Numerous small diameter trees and brush populated the terrain east of the ditch. A 99.0 cm (39.0 in) diameter hardwood tree located (11.0 ft) east of the road edge was the point of impact. **Figure 2** is a northbound trajectory view at the crash site. **Figure 3** is a view of the point of impact. The speed limit in the area of the crash site was 64 km/h (40 mph).



**Figure 2: Northbound trajectory view.**



**Figure 3: Point of impact.**

## **CRASH SEQUENCE**

### **Pre-Crash**

The 2004 Nissan Pathfinder, **Figure 4**, was northbound and was driven by a 16 year old male driver. The driver was restrained by the vehicle's manual safety belt. He was the vehicle's sole occupant. For unknown reasons, the driver failed to negotiate the left curve and departed the right road edge at the approximate apex of the curve. There was no physical evidence that indicated the exact point of road side departure. The driver had no recollection of the crash.

### **Crash**

The Nissan departed the right edge of the road at a shallow angle (estimated between 5 to 10 degrees relative to the road). The Nissan traveled along the road shoulder an estimated 15 to 18 m (50 ft to 60 ft). The right side of the vehicle contacted and sheared the overhanging branches and brush along the road side. This contact began 13 m (43 ft) south of the point of impact. The Nissan traveled through the road side ditch, climbed the embankment, and impacted the 99 cm (39 in) diameter hardwood tree with its front plane. A 76 cm x 61 cm (30 in x 24 in) area of bark was removed from the tree during the impact. The area of removed bark began 23 cm (9 in) above the ground. The front plane of the vehicle deformed into a U-shaped pattern around the tree. The Nissan then rotated approximately 90 degrees and came to rest facing east. The delta V of the impact calculated by the Damage Algorithm of the WINSMASH model was 61 km/h (38 mph). The longitudinal and lateral components of the delta V were -61 km/h (-38 mph) and 0 km/h (0 mph), respectively. A schematic of the crash is included at the end of this report as **Figure 11**.



**Figure 4: Front right oblique view of the Nissan.**

### **Post-Crash**

The police, fire and EMS personnel responded to the crash site. The driver was trapped within the vehicle and extricated after approximately 15 minutes. He was conscious with a Glasgow Coma Score of 15. He was transported to a regional trauma center located within 24 km (15 miles) of the crash site. He was admitted and hospitalized for two days as a precaution to the possibility of an occult abdominal injury. An abdominal injury was ruled out and the driver was discharged. He suffered two right metacarpal (finger) fractures, safety belt related abdominal abrasions, a lower lip abrasion, and a left lower extremity contusion. The Nissan was towed from the scene and considered a total loss by its insurance company.

## **2004 NISSAN PATHFINDER**

### **Exterior Damage**

**Figures 5 and 6** are the front and right side views of the Nissan. The front plane of the Nissan Pathfinder sustained severe damage as a result of the impact. The width of the direct and induced damage extended across the vehicle's entire 165 cm (65 in) end width. The direct



contact damage measured 97 cm (38 in) and began 41 cm (16 in) left of center. The direct contact damage ended 56 cm (22 in) right of center. The frontal structures crushed rearward and wrapped around the circumference of the tree. The front wheels towed inward. The hood buckled and folded. The impact was biased slightly to the right of center. The crush profile measured across the front bumper was as follows: C1 = 19 cm (7.5 in), C2 = 51 cm (20.1 in), C3 = 84 cm (33.1 in), C4 = 98 cm (38.6 in), C5 = 85 cm (33.5 in), C6 = 67 cm (26.4 in). The maximum crush was located 21 cm (8.3 in) right of center at the C4 crush measurement. The left front, left rear, and right rear doors were operational post-crash. The right front door was jammed shut. The windshield was in place and fractured. The front right window glazing and then backlight disintegrated. The left wheelbase measurement was unchanged. The right wheelbase was reduced 12 cm (4.8 in). The Collision Deformation Classification (CDC) was 12-FDEW4.



Figure 5: Front view of the Nissan.



Figure 6: Right side view.

### *Interior Damage*

The interior damage to the Nissan consisted of moderate toe pan and instrument panel intrusion, deployment of the frontal air bags, deployment of the right side impact inflatable protection and the driver interior contact points. The toe pan intrusion measured 13 cm (5 in). The left instrument panel intruded 8 cm (3 in). The right instrument panel intruded 15 cm (6 in). **Figure 7** is a left view of the driver's interior. Minor intrusions of the center instrument panel and the left floor pan were also documented.



Figure 7: Left interior view.

The driver seat was located in a mid track position 13 cm (5.3 in) forward of full rear. The total seat track travel measured 23 cm (9 in). The seat back was reclined 10 degrees. The horizontal distance from the seat back to the center hub of the four spoke steering wheel measured 34 cm (13.5 in). The tilt steering column was in a center position. There was no deformation of the steering wheel rim and no shear capsule displacement. The driver's knee bolster was fractured



by contact from the driver's left lower extremity. The contact was located 23 cm (9 in) left of the steering column center line. No other driver contacts were identified.

### ***Manual Restraint System***

The driver's manual restraint consisted of a 3-point lap and shoulder belt with continuous loop webbing, a sliding latch plate, adjustable D-ring and an Emergency Locking Retractor in the base of the B-pillar. The retractor was designed with a pretensioner that fired as a result of the crash. The D-ring was in the full down position. Upon initial examination the webbing was in an extended position and the retractor was locked by the fired pretensioner. The length of the extended webbing measured 168 cm (66 in). The webbing was abraded and creased from D-ring loading. The abrasion was located 164 cm (64.5 in) from the floor anchor. Examination of the latch plate revealed evidence of historical use and the hardware was abraded. The physical evidence observed at the time of the SCI inspection indicated the driver was restrained at the time of the crash.

The front right manual restraint was stowed within its retractor and the webbing was under tension. The state of the webbing indicated that the front right pretensioner fired during the crash.

### ***Advanced Occupant Protection System***

The Nissan Pathfinder was equipped with an Advanced Occupant Protection System (AOPS) that consisted of dual stage driver and front right passenger air bags. The frontal air bags deployed as a result of the tree impact. The driver air bag deployed from a tri-flap design module located in the center hub of the steering wheel. The upper half of the cover flap consisted of two 5 cm x 8 cm (2 in x 3 in) flaps that separated along a vertical center seam. The lower flap measured 15 cm x 11 cm (5.8 x 4.5 in), width by height, and separated from the upper flaps at the horizontal seam. There was no occupant contact evidence to the cover flaps. The driver air bag, **Figure 8**, measured 58 cm (23 in) in its deflated state. It was tethered by two internal straps and vented by two ports located on the back side of the bag in the 11/1 o'clock sectors. There was no evidence of occupant contact to the face of the driver air bag. The only noted physical evidence was the presence of a post-crash blood transfer to the 3 o'clock sector on the back side of the bag.



**Figure 8: Driver air bag.**

The front right passenger air bag deployed from an H-configuration module located in the right aspect of the instrument panel. The front right passenger air bag measured 47 cm x 55 cm (18.5 in x 21.5 in) in its deflated state. It was not tethered and was vented by two ports located on the side panels of the bag. There was no evidence of occupant contact.

### ***Inflatable Side Impact Protection***

The subject Nissan Pathfinder was equipped with optional inflatable side impact protection that consisted of front seat back mounted thorax bags and roof rail mounted side curtains. The right front right thorax bag and the right side curtain deployed in this crash. The right side impact protection probably deployed as a result of the rapid clockwise rotation of the vehicle to final rest.

The thorax bag, **Figure 9**, deployed from a module mounted in the outboard bolster of the front right seat back. During the deployment, the fabric seam of the bolster separated over a 36 cm (14 in) length creating a deployment path for the air bag. The air bag deployed in a forward direction and measured 33 cm x 30 cm (13 in x 12 in), length by height.

The inflatable side curtain deployed vertically downward from its mounting in the right roof rail. The air bag was rectangular in shape and measured 145 x 41 cm (57.3 in x 16 in), length by height. The air bag provided coverage from a point approximately 53 cm (21 in) forward of the B-pillar (center) rearward to the C-pillar (beyond the second row). **Figure 10** is an interior view of the deployed side curtain.



**Figure 9: Thorax bag.**



**Figure 10: Deployed side curtain.**

### ***DRIVER DEMOGRAPHICS***

Age/Sex: 16 year old/Male  
Height: Not reported  
Weight: 45 kg (100 lb)  
Seat Position: Mid-track position  
Restraint Use: Three-point lap and shoulder belt  
Usage Source: SCI inspection, PAR  
Medical Treatment: Transported by ambulance to a trauma center and hospitalized for two days

### ***DRIVER INJURY***

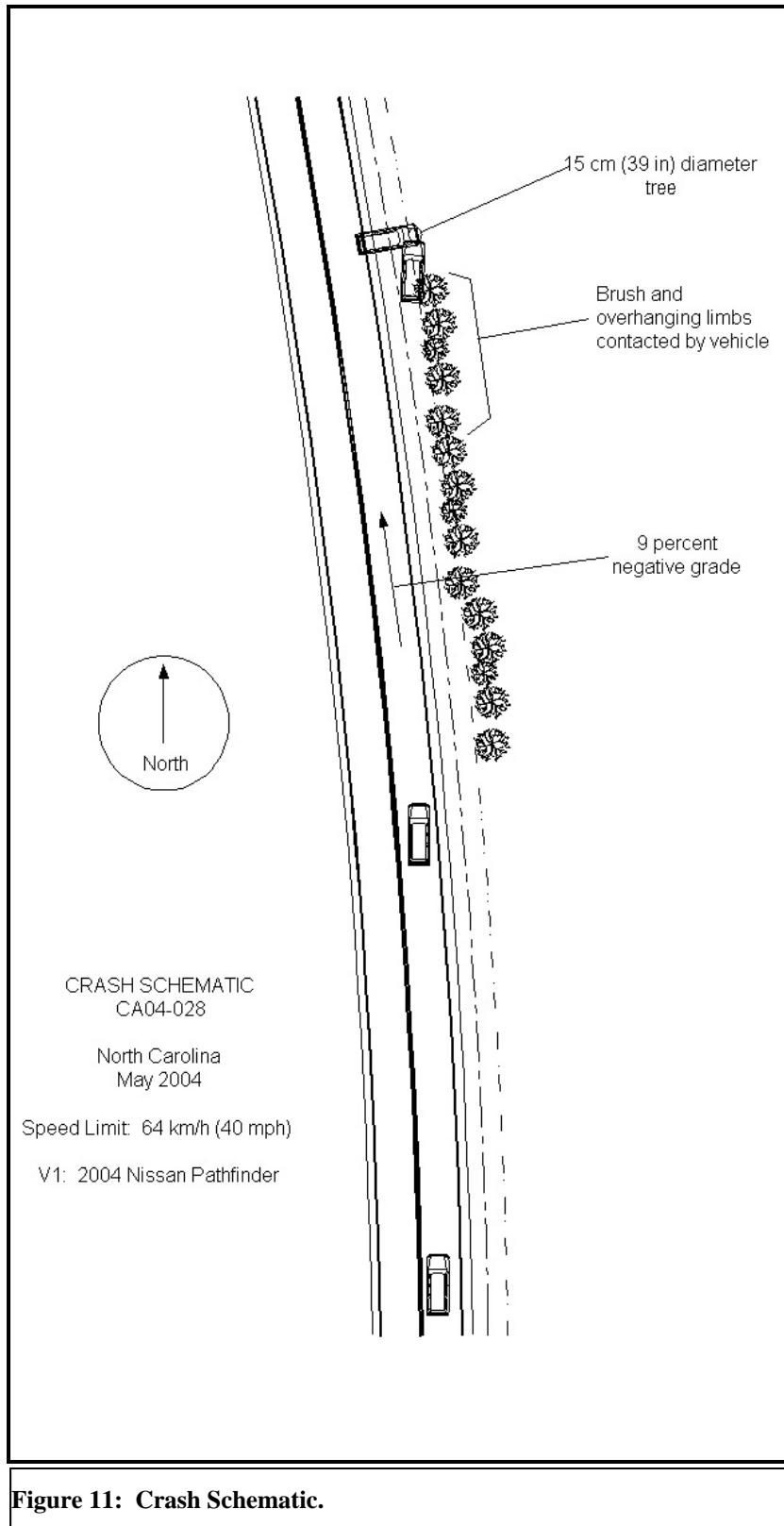
<b><i>Injury</i></b>	<b><i>Injury Severity (AIS 98 update)</i></b>	<b><i>Injury Mechanism</i></b>
Acute displaced fracture through the distal shaft of the right 3 <sup>rd</sup> metacarpal and acute fracture of proximal end of right 4 <sup>th</sup> metacarpal	Moderate (752002.2)	Instrument panel
Lower lip abrasion	Minor (290202.1,8)	Deployed driver air bag
Abrasions to the central abdomen	Minor (590402.1,4)	Safety belt
Left lower extremity contusion	Minor (890402.1,2)	Knee bolster

*Note: the above referenced injuries were identified in the driver's Emergency Room records and Discharge Summary*

### ***DRIVER KINEMATICS***

At the time of the crash, the 16 year old male driver was seated in a mid-track position in a presumed upright posture. He was restrained by the vehicle's manual safety belt. The vehicle departed the right side of the road near the apex to the left curve. The Nissan traveled along the road shoulder an estimated 15 to 18 m (50 ft to 60 ft) at an impact with the large diameter tree. Due to the short passage of time between the road departure and the impact, the driver's position was not altered by this dynamic. It was probable he was trying to regain directional control of the vehicle. The driver had no recollection of the crash.

Upon impact, the safety belt pretensioner fired and the frontal air bags deployed. The pretensioner removed potential belt slack and tightened the safety belt about the driver. The driver responded to the 12 o'clock direction of the impact by initiating a forward trajectory. The driver contacted and loaded the seat belt system evidenced by the abrasions to his central abdomen. The driver's head and chest contacted the deployed driver air bag. The driver's lower lip abrasion occurred during this contact. The forward translation of the driver resulted in his contact to the knee bolster and the identified contusion. The force of the impact displaced the driver's right hand from the steering wheel and his right hand impacted the instrument panel. This contact resulted in fractures of the 3<sup>rd</sup> and 4<sup>th</sup> metacarpals. As the vehicle rotated to final rest, the driver then rode down the force of the crash through his continued loading of the safety belt and driver air bag. The driver then rebounded back into his seat where he was found.



**Figure 11: Crash Schematic.**