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OFFICE OF DEFECTS INVESTIGATION
CALSPAN ON-SITE AIR BAG NON-DEPLOYMENT CRASH INVESTIGATION

SCI CASE NO: CA09026

VEHICLE: 2008 NISSAN TITAN
LOCATION: PENNSYLVANIA
CRASH DATE: MARCH, 2009

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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 on-site investigation focused on the crash dynamics, crash severity, injury and injury sources surrounding the intersection crash of a 2008 Nissan Titan pickup truck and a 2002 Chrysler Voyager. The Nissan was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that did not deploy as a result of the crash. The CAC system in the Nissan was comprised of advanced dual-stage frontal air bags, a seat track position sensor, front safety belt buckle switches, front safety belt pretensioners, and a front right occupant detection sensor. The frontal air bags in the Titan were certified by the manufacturer to be compliant with the advanced air bag requirements of the Federal Motor Vehicle Safety Standard No. 208. This crash was brought to the attention of the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigation (ODI) by the owner of the Nissan. The owner was concerned about the non-deployment of the Nissan's frontal air bags. The ODI conducted a follow-up interview with the driver and requested further research of the crash through the Special Crash Investigations (SCI) Program. The Crash Investigation Division of the NHTSA forwarded the vehicle owner's contact information to the Calspan SCI team on April 29, 2009. The Calspan SCI team interviewed the driver and scheduled an inspection of the vehicle. The SCI team also contacted Nissan North America and made arrangements to acquire the scan tool necessary to image the data stored within the vehicle's Event Data Recorder (EDR). The crash scene and the Nissan were inspected on May 7, 2009. The Nissan's EDR data was successfully imaged at that time. Insurance carrier images of the damaged Chrysler Voyager were obtained and reviewed.

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BACKGROUND

This on-site investigation focused on the crash dynamics, crash severity, injury and injury sources surrounding the intersection crash of a 2008 Nissan Titan pickup truck and a 2002 Chrysler Voyager. The Nissan was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that did not deploy as a result of the crash. The CAC system in the Nissan was comprised of advanced dual-stage frontal air bags, a seat track position sensor, front safety belt buckle switches, front safety belt pretensioners, and a front right occupant detection sensor. The frontal air bags in the Nissan were certified by the manufacturer to be compliant with the advanced air bag requirements of the Federal Motor Vehicle Safety Standard No. 208.

Figure 1: Front right view of the Nissan.

This crash was brought to the attention of the National Highway Traffic Safety Administration's (NHTSA) Office of Defects Investigation (ODI) by the owner of the Nissan. The owner was concerned about the non-deployment of the Nissan's frontal air bags. The ODI conducted a follow-up interview with the driver and requested further research of the crash through the Special Crash Investigations (SCI) Program. The Crash Investigation Division of the NHTSA forwarded the vehicle owner's contact information to the Calspan SCI team on April 29, 2009. The Calspan SCI team interviewed the driver and scheduled an inspection of the vehicle. The SCI team also contacted Nissan North America and made arrangements to acquire the scan tool necessary to image the data stored within the vehicle's Event Data Recorder (EDR). The crash scene and the Nissan were inspected on May 7, 2009. The Nissan's EDR data was successfully imaged at that time. Insurance carrier images of the damaged Chrysler Voyager were obtained and reviewed.

SUMMARY

VEHICLE DATA

2008 Nissan Titan

The 2008 Nissan Titan SE was identified by the Vehicle Identification Number (VIN): 1N6AA07C08N (production sequence deleted) and was manufactured in July 2007. The four-wheel drive, four-door crew cab pickup truck was equipped with a 5.6 liter, V8 engine, a five-speed automatic transmission, and four-wheel anti-lock brakes. The Gross Vehicle Weight

Rating (GVWR) was 3,266 kg (7,200 lb). The Titan was manufactured on a 355 cm (139.8 in) wheelbase. The odometer indicated 20,177 km (12,538 miles) at the time of the inspection. The manual restraint system consisted of three-point lap and shoulder safety belts in the five seat positions. The front safety belts were equipped with retractor pretensioners. The frontal air bag system consisted of Certified Advanced Compliant (CAC) air bags for the driver and front right passenger. It was not equipped with side impact air bags. The Nissan was equipped with Goodyear Wrangler SRA P265/70R18 tires mounted on OEM alloy rims. The vehicle manufacturer's recommended cold tire pressure was 240 kPa (35 PSI) front and rear. The specific measured tire data at the time of the SCI inspection was as follows:

Tire	Measured Pressure	Tread Depth	Restricted	Damage
LF	269 kPa (39 PSI)	6 mm (7/32 in)	No	None
LR	269 kPa (39 PSI)	6 mm (7/32 in)	No	None
RF	262 kPa (38 PSI)	6 mm (7/32 in)	No	None
RR	269 kPa (39 PSI)	5 mm (6/32 in)	No	None

2002 Chrysler Voyager

The 2002 Chrysler Voyager LX was identified by the Vehicle Identification Number (VIN): 1C8GJ45372B (production sequence deleted) and was manufactured in September 2001. The front-wheel drive, four-door minivan was equipped with a 3.3 liter V6 engine and four-speed automatic transmission. The vehicle was equipped with the LX trim package to include dual stage front air bags and front seat back mounted side impact air bags. The insurance records indicated the Chrysler had registered 159,509 km (99,117 miles). The vehicle was considered a total loss by its insurance carrier.

CRASH SITE

The crash occurred during the daylight hours of March 2009. At the time of the crash, the weather was clear and the road was dry. The crash occurred at the three-leg intersection of a two-lane north/south road and a two-lane east/west road. The east/west road intersected the primary road from the east. The westbound traffic was controlled by a stop sign. On the northbound approach to the intersection, there was a left curve that ended approximately 90 m (295 ft) south of the intersection. Northbound traffic descended a short downgrade (estimated at 4 percent) approximately 60 m (200 ft) south of the intersection. The grade through the intersection was level. The east road side was an open field. There were no apparent obstructions that would have affected either driver's visibility to the respective traffic. The speed limit in the area of the crash was 64 km/h (40 mph). **Figure 2** is a northbound trajectory view of the Nissan 61 m (200 ft) from the intersection. **Figure 3** is a southward view from the intersection, the perspective of the Chrysler to northbound traffic. At the time of the SCI scene inspection, there was no observed physical evidence that was related to this crash event.

Figure 2: Northbound trajectory view of the Nissan.

Figure 3: Southward view from the intersection; the perspective of the Chrysler to northbound traffic.

CRASH SEQUENCE

Pre-Crash

The 2002 Chrysler Voyager was driven by a 55-year-old restrained male. The Chrysler was stopped at the three-leg intersection and it was the driver's intention to turn left and travel south. The 2008 Nissan Titan was northbound driven by 35-year-old restrained female. The Nissan was traveling an EDR recorded speed of 64 km/h (40 mph) seven seconds (7 sec) prior to the crash. The Chrysler Voyager accelerated forward from the stop sign and into the path of the Nissan. The Nissan's EDR data indicated that the driver applied the brakes two seconds (2 sec) prior to the crash in an attempt to avoid the Chrysler. A schematic of the crash is included at the end of this report as **Figure 9**.

Crash

The front plane of the Nissan impacted the forward aspect of the Chrysler's left side plane in a T-configuration. The direction of force was within the 12 o'clock sector for the Nissan and 10 o'clock sector for the Chrysler. The EDR reported speed of the Nissan was approximately 47 km/h (29 mph) one second prior (-1 sec) to the impact. The force of the impact caused the Chrysler to rotate clockwise and separate with a northeast trajectory. The Nissan's momentum carried it north through the intersection where it came to a controlled stop on the road side. The CAC driver air bag in the Nissan did not deploy. The redesigned frontal air bags in the Chrysler did deploy.

The severity of the crash (delta-V) was calculated by the CDC Only Algorithm of the WinSMASH program. The total delta-V of the Nissan was 21 km/h (13 mph). The longitudinal and lateral components of the delta-V were -21 km/h (-13 mph) and -4 km/h (-2 mph), respectively. The total delta-V of the Chrysler was 28 km/h (17 mph). The longitudinal and lateral components of the delta-V were -14 km/h (-9 mph) and 24 km/h (15 mph), respectively. The WINSMASH results were considered borderline due to the lack of measured crash specific data for the Chrysler and the use of the CDC Only Algorithm. The maximum EDR recorded

delta-V of the Nissan was 15 km/h (9 mph), 70 milliseconds after the impact. The recorded EDR delta-V appeared consistent with the crash damage and crash dynamics.

Post-Crash

The police responded to the crash scene. Both drivers exited their respective vehicles under their own power. The driver of the Nissan sustained minor knee contusions from knee bolster contact and seat belt related contusions to her chest. The Chrysler driver sustained police reported minor injuries. Neither driver was transported for medical treatment at the time of the crash. However, the driver of the Nissan did seek treatment for her injuries from her personal physician at a later date

2008 NISSAN TITAN

Exterior Damage

The Nissan Titan sustained damage across the full frontal plane as a result of the impact (**Figures 4 and 5**). At the time of the SCI inspection, the Nissan had been partially disassembled to facilitate an insurance damage estimate. The damaged components included: the front bumper, bumper reinforcement, the head lamp assemblies, the center grille, the upper radiator support, radiator, condenser and associated components. These components had been discarded prior the SCI inspection. The left fender was shifted rearward. The residual crush measured along the bumper reinforcement bar was as follows: C1 = 5 cm (2 in), C2 = 15 cm (5.9 in), C3 = 24 cm (9.4 in), C4 = 19 cm (7.5 in), C5 = 15 cm (5.9 in), C6 = 8 cm (3.1 in). The maximum residual crush was located 9 cm (3.7 in) left of center and measured 24 cm (9.4 in). The dynamic crush of the frontal components resulted in contact between the back side of the radiator and the cooling fan. This contact was evidenced by damage to the radiators fins and a fractured fan blade. There was no change in the wheelbase dimensions. All the doors remained closed during the crash and were operational at the time of the SCI inspection. There was no damage to the windshield and all the window glazing was intact.

Figure 4: Frontal view of the damaged Nissan.

Figure 5: Left lateral view at the front plane.

2002 CHRYSLER VOYAGER

Exterior Damage

Insurance carrier photographs of the Chrysler were obtained and used to assess the damage to the Chrysler. **Figure 6** is a left front view of the Chrysler. The direct contact damage to the Chrysler began at the left corner and extended an estimated 127 cm (50 in) along the left side plane to the forward aspect of the left front door. The lateral crush at the left corner was an estimated 38 cm (15 in). The force of the impact deformed the left front suspension inboard and damaged the wheel assembly. The redesigned frontal air bags in the Voyager deployed. The estimated CDC was 10-LYAW3.

Figure 6: Left front oblique view of the Chrysler. This image was provided by the insurance carrier.

2008 NISSAN TITAN

Interior Damage

There was no damage to the interior of the Nissan as a result of the exterior crash force. **Figure 7** is a left view of the front interior.

Figure 7: Left interior view.

The driver seat was located in a mid-track position 9 cm (3.5 in) forward of full-rear. The total seat track travel was 25 cm (10 in). The seat back was reclined 25 degrees aft of vertical. The horizontal distance from the seat back to the driver air bag module measured 61 cm (24 in). There was no deformation to the three-spoke steering wheel rim. There was no shear capsule separation. Three minor occupant contact points to the left knee bolster were identified. A 3 cm (1 in) diameter scuff was located 20 cm (7.7 in) left of the steering column center line. A 5 cm (2 in) diameter scuff was located 8 cm (3 in) left of the steering column. A 3 cm (1 in) diameter scuff was located 14 cm (5.7 in) right of the steering column. These scuffs were all located approximately 48 cm (19 in) above the floor. These contact points were attributed to contact from the lower extremities of the driver.

Manual Restraint Systems

The driver's three-point lap and shoulder safety belt consisted of a continuous loop webbing, sliding latch plate, Emergency Locking Retractor (ELR) and an adjustable D-ring. The retractor was equipped with a pretensioner. The D-ring was in the full-down position. At inspection, the safety belt was stowed within the retractor and the retractor was operational. The driver pretensioner did not actuate in the crash. Examination of the latch plate revealed minor historical usage evidence. There was no crash related evidence of use on the latch plate friction surface,

belt webbing or D-ring. However SCI field experience has shown that observable safety belt usage evidence is not always apparent in crashes of minor severity (low delta V). The lack of occupant contact and damage to the steering assembly and to the windshield, coupled with only minimal knee bolster contacts, indicated to the SCI investigator that this driver was restrained at the time of the crash. The EDR data indicated that the driver's safety belt was buckled at the time of the crash.

The front right passenger's restraint consisted of a continuous loop webbing, sliding latch plate, a switchable Automatic Locking Retractor/ELR (ALR/ELR) and an adjustable D-ring. This restraint was not buckled (not in use) at the time of the crash. The front right retractor pretensioner actuated during the crash with the webbing in the stowed position. The webbing was gathered in the D-ring and the retractor was not operational. The webbing on the back side of the D-ring was abraded from contact with the D-ring surface as the pretensioner actuated. The diagnostic routine of the vehicle's Air bag Control Module (ACM) stored a Diagnostic Trouble Code (DTC) that confirmed the pretensioner actuation. The cause of the pretensioner actuation in an unoccupied seat position could not be determined.

Figure 8: Front right D-ring and gathered webbing.

Air Bag System

The frontal air bag system in the Nissan was controlled by an Air bag Control Module (ACM) that had Event Data Recording (EDR) capabilities. The driver air bag module was located in the center hub of the steering wheel. The front right passenger air bag was a top mount design located in the right aspect of the instrument panel. The frontal air bags did not deploy in the minor severity crash.

Event Data Recorder

The Nissan's electrical system was intact and the battery was charged. The ignition was cycled to the "On" position and the *Air Bag* indicator lamp in the instrument cluster was observed. At ignition, the ACM conducted its diagnostic routine evidenced by the flashing indicator lamp. The lamp flashed 6 times and then remained in a steady illuminated phase. The illuminated phase of the lamp indicated the presence of Diagnostic Trouble Codes (DTC's).

The proprietary scan tool obtained from Nissan North America was used to communicate with the EDR and image the stored data. The scan tool was connected to the Diagnostic Link Connector located under the left instrument panel. The software driven scan tool was powered via the Nissan's electrical system and communicated to the ACM directly across the vehicle's communication bus. The following data was imaged during the SCI inspection.

The crash occurred on Ignition Cycle 2601 and was imaged on Cycle 2622. The record indicated the EDR data was complete and successfully recorded after the crash event. The imaged data

indicated that there were no historical DTC's present prior to the crash. This was an indicator that the *Air Bag* light in the instrument cluster was "Off" prior" to the crash and the air bag system was operational.

Two DTC's were present at the time of the data imaging and were defined by the scan tool. These codes indicated that:

1. a frontal crash was detected;
2. the front right pretensioner circuit was "Open" (i.e. actuated).

The presence of the DTC's was the cause of the illuminated ("On") state of *Air Bag* indicator lamp.

The EDR recorded fourteen seconds (14 sec) of Speed, RPM, Throttle Position, Brake Switch data. Time "Zero" (0 sec) was assumed to indicate the impact event. The data imaged from the EDR is listed in the following table:

Time (sec)	Speed	Engine Speed (RPM)	Throttle Position (%)	Brake Switch Status
-7	64 km/h (40 mph)	1459	6	Off
-6	65 km/h (40 mph)	1466	6	Off
-5	65 km/h (40 mph)	1475	6	Off
-4	66 km/h (41 mph)	1500	6	Off
-3	68 km/h (42 mph)	1541	6	Off
-2	69 km/h (43 mph)	1578	0	On
-1	47 km/h (29 mph)	1209	0	On
0	19 km/h (12 mph)	741	0	On
1	20 km/h (12 mph)	800	0	On
2	15 km/h (9 mph)	900	0	On
3	8 km/h (5 mph)	725	0	On
4	3 km/h (2 mph)	675	0	On
5	0	666	0	On
6	0	788	0	On

The EDR also recorded the longitudinal delta V of the Nissan and is listed in the table below. The maximum longitudinal delta-V was 15 km/h (9 mph). The EDR had memory to record 300 milliseconds of delta-V data. The delta-V in this crash reached a plateau at 80 milliseconds and the recording stopped. Unwritten default data (FF) resided in memory location Zero and memory locations 90 to 300 milliseconds. The maximum frontal acceleration was 14.65 g at 36 milliseconds.

Time (milliseconds)	Frontal Delta-V
0	FF
10	1 km/h (1 mph)
20	2 km/h (1 mph)
30	6 km/h (4 mph)

Time (milliseconds)	Frontal Delta-V
40	10 km/h (6 mph)
50	12 km/h (7 mph)
60	14 km/h (9 mph)
70	15 km/h (9 mph)
80	15 km/h (9 mph)
90 to 300	FF

The recorded delta V was consistent with the vehicle's minimal frontal damage based on SCI field experience.

DRIVER DEMOGRAPHICS

	Driver
Age / Sex:	35-year-old / Female
Height:	168 cm (66 in)
Weight:	59 kg (130 lb)
Seat Track Position:	Mid-track position
Restraint Use:	3-point lap and shoulder safety belt
Usage Source:	SCI interior inspection, interview, EDR
Medical Treatment:	Sought treatment at a later date

DRIVER INJURY

Injury	***Injury Severity (AIS 90/Update 98)***	***Injury Source***
Chest contusions, NFS	Minor (490402.1,2)	Safety belt loading
Bilateral lower extremity contusions, NFS	Minor (890402.1,3)	Knee bolster

Source: Interview

DRIVER KINEMATICS

The 35-year-old restrained female driver of the Nissan was seated in a mid-track position in an upright posture. She was operating the vehicle at an EDR reported speed of 64 km/h (40 mph), seven seconds (7 sec) prior to the crash. The driver applied the brakes two seconds (2 sec) prior to the crash and reduced the vehicle's speed to approximately 47 km/h (29 mph) at the time of the impact.

At impact, the safety belt's inertial mechanism locked the retractor. The driver initiated a forward trajectory in response to the 12 o'clock direction of the impact force and loaded the locked belt system. She rode down the force of the impact and sustained chest contusions due to the safety belt loading. The driver's lower extremities contacted the bolster evidenced by the

scuffs to that component and corresponding contusions to that body area. She rebounded back into the driver seat and came to rest.

The use of the safety belt reduced the driver's potential contact to the interior and mitigated further injuries. The restrained driver was adequately protected in this minor severity crash. She was not transported to a medical facility.

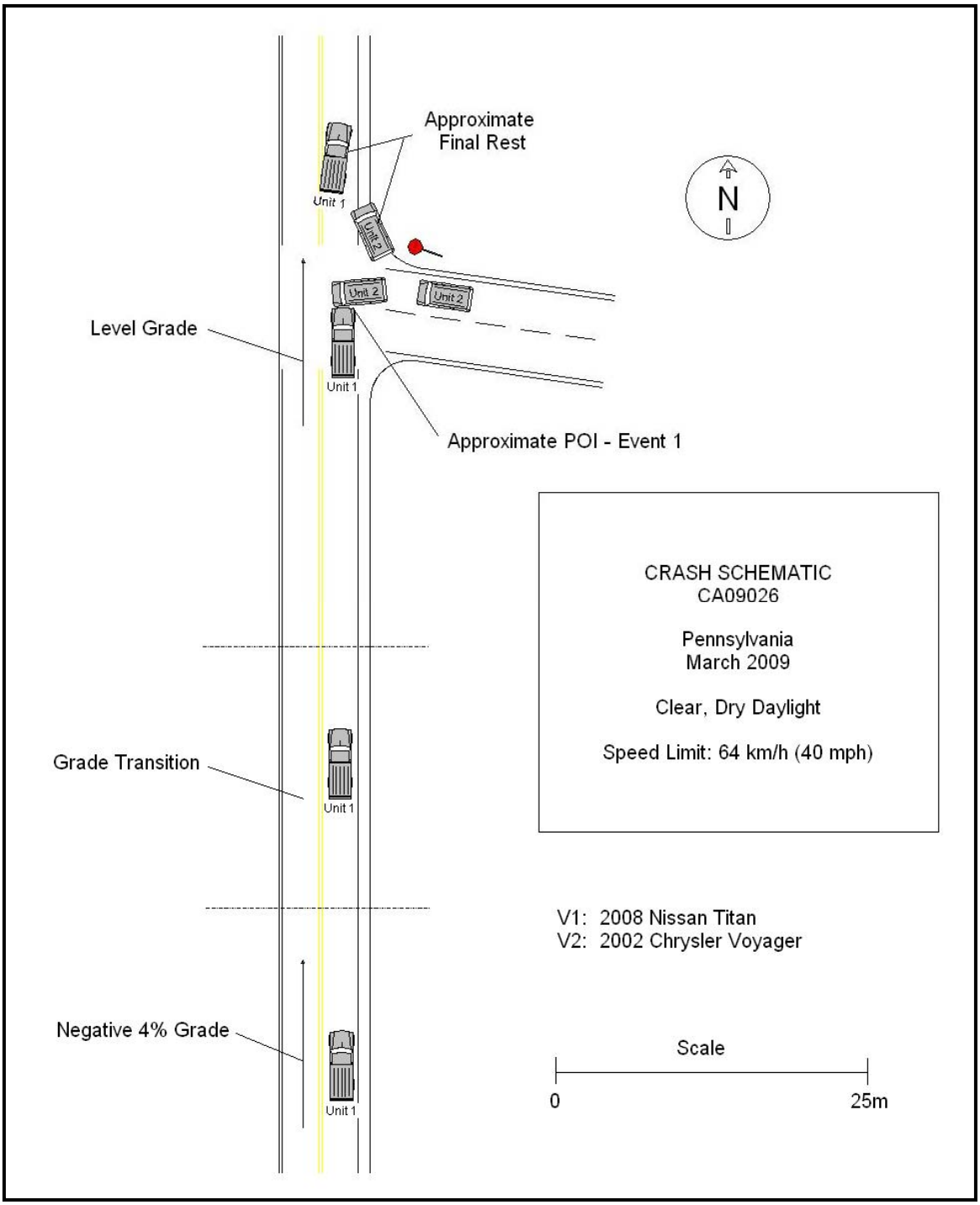

Figure 9: Crash Schematic.