TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS CDS CASE NO. 1998-45-088J

RABSS VEHICLE - 1998 NISSAN PATHFINDER SPORT UTILITY

LOCATION - STATE OF TENNESSEE

CRASH DATE - JUNE, 1998

Contract No. DTNH22-94-D-07058

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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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15. *Supplementary Notes* NASS investigation of a frontal collision (into a fixed object) that involved a 1998 Nissan Pathfinder sport utility vehicle with redesigned frontal air bags.			
16. *Abstract* This investigation focused on a single vehicle crash involving a 1998 Nissan Pathfinder sport utility. The Nissan Pathfinder was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a utility pole. The driver was operating the vehicle westbound on a two lane rural roadway when she apparently lost consciousness due to low blood sugar and allowed the vehicle to depart the right (north) pavement edge. As the vehicle exited the north pavement edge, it struck a mailbox, landscaping wall, guy wire and a chain link fence. At this point, the front right area impacted a large diameter utility pole resulting in moderate damage. The vehicle subsequently rotated clockwise 100 degrees and re-entered the roadway where it came to rest facing northeast. The 38 year old female driver was unrestrained (3-point manual lap and shoulder belt system available) with the seat track adjusted to the middle position. At impact with the utility pole, she initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag propelled her hands into the windshield resulting in an abrasion to the posterior right hand. She loaded the deployed redesigned driver air bag which resulted in a contusion to the mid-chest and an (indirect) compression fracture of the thoracic spine. The driver was transported to a local hospital for treatment and admitted for four days. The 11 year old male front right passenger was restrained by the available 3-point lap and shoulder belt system with the seat track adjusted to the full rearward position. At impact with the utility pole, he also initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and redesigned passenger air bag. Loading of the air bag resulted in a contusion to the forehead. The front right passenger was not transported for treatment but accompanied his mother to the hospital.			
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BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Nissan Pathfinder sport utility. The Nissan Pathfinder was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with a utility pole. The driver was operating the vehicle westbound on a two lane rural roadway when she apparently lost consciousness due to low blood sugar and allowed the vehicle to depart the right (north) pavement edge. As the vehicle exited the north pavement edge, it struck a mailbox, landscaping wall, guy wire and a chain link fence. At this point, the front right area impacted a large diameter utility pole resulting in moderate damage. The vehicle subsequently rotated clockwise 100 degrees and re-entered the roadway where it came to rest facing northeast. The 38 year old female driver was unrestrained (3-point manual lap and shoulder belt system available) with the seat track adjusted to the middle position. At impact with the utility pole, she initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag propelled her hands into the windshield resulting in an abrasion to the posterior right hand. She loaded the deployed redesigned driver air bag which resulted in a contusion to the mid-chest and an (indirect) compression fracture of the thoracic spine. The driver was transported to a local hospital for treatment and admitted for four days. The 11 year old male front right passenger was restrained by the available 3-point lap and shoulder belt system with the seat track adjusted to the full rearward position. At impact with the utility pole, he also initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and redesigned passenger air bag. Loading of the air bag resulted in a contusion to the forehead. The front right passenger was not transported for treatment but accompanied his mother to the hospital.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-45-088J and was also included in the Redesigned Air Bag Special Study. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This single vehicle crash occurred during the afternoon hours of June, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred off the north pavement edge of a straight, two lane east/west (rural) asphalt roadway **(see Figure 7 - page 8)**. The

roadside environment included a shallow ditch with driveway culverts. No traffic controls were present at the scene which had a posted speed limit of 48 km/h (30 mph).

Pre-Crash

The 38 year old female driver of the 1998 Nissan Pathfinder was operating the vehicle westbound **(Figure 1)** when she apparently lost consciousness due to low blood sugar (confirmed by EMS at the scene post-crash) and allowed the vehicle to drift off the right (north) pavement edge. Upon recognition of the impending harmful event, the 11 year old male front right passenger attempted to reach over and revive the driver, but to no avail.

Figure 1. Westbound approach for the 1998 Nissan Pathfinder.

Figure 2. Utility pole impact location (pole replaced).

Crash

As the Nissan departed the north pavement edge of the two lane rural roadway, the front right area struck a small diameter mailbox post resulting in minor damage. The vehicle continued 9.5 meters (31.2 feet) in a westerly direction and impacted a (low profile) landscaping wall adjacent to a private driveway. This impact resulted in minor undercarriage damage. The vehicle continued for another 12.8 meters (42.0 feet) before contacting a utility pole guy wire (anchorage/stake uprooted) which resulted in minor (overlapping) frontal damage. At this point, the front right area struck a chain link fence resulting in minor damage. The front right area subsequently impacted a 30.5 cm (12.0 in) utility pole resulting in moderate (overlapping) damage **(Figure 2)**. The impact induced deceleration was sufficient to deploy the Nissan's redesigned frontal air bag system. Although the impact was classified as out of scope (yielding object/overlapping damage), the damage algorithm of the WinSMASH program computed a (barrier equivalent) velocity change of 30.4 km/h (18.9 mph). The respective longitudinal component was -30.4 km/h (-18.9 mph). The Nissan rotated clockwise 100 degrees and re-entered the roadway where it came to rest perpendicular to the travel lanes facing northeast. **Table 1** identifies the Event number, the Object Struck and the respective Collision Deformation Classification (CDC) for each impact for the Nissan in the multiple event crash sequence.

Table 1
Impact Events for the 1998 Nissan Pathfinder

Event Number	Object Contacted	CDC
1	Mailbox post	12-F999-9
2	Landscaping wall (low profile type)	12-UYZW-1
3	Guy wire	12-FCLN-1
4	Chain link fence	12-FRAS-9
5	Utility pole	12-FREE-3

Post-Crash

The driver of the Nissan was removed from the vehicle while unconscious. The front right passenger was removed with some assistance. Treatment was rendered at the scene by emergency medical technicians (EMT). The driver was transported to a local hospital for treatment and admitted for four days. The vehicle was towed from the scene.

RABSS VEHICLE

The 1998 Nissan Pathfinder was identified by the Vehicle Identification Number (VIN): JN8AR05Y4WW (production sequence deleted). The police report listed the driver as the owner of the vehicle. The vehicle was a 4-door sport utility equipped with 4-wheel drive and a 3.3 liter, V-6 engine. The vehicle's odometer reading was 4,828 km (3,000 miles) at the time of the crash. The seating was configured with front bucket seats and a rear split bench (with folding backs). The driver reported no previous crashes or maintenance on the air bag system (original equipment). No cell phone was present or in use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

The Nissan Pathfinder sustained moderate (overlapping) frontal damage as a result of the impact with the utility pole **(Figure 3)**. The direct contact damage began at the front right bumper corner and extended 35.0 cm (13.8 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 130.0 cm (51.2 in). Six crush measurements were documented at the level of the bumper: C1= 0 cm, C2= 0 cm, C3= 9.0 cm (3.5 in), C4= 21.0 cm (8.3 in), C5= 37.0 cm (14.6

Figure 3. Frontal damage to the 1998 Nissan Pathfinder.

in), C6= 54.0 cm (21.3 in). Damage was noted to the right fender which restricted the right front wheel/tire (not deflated) and jammed the right front door. The right wheelbase was displaced 22.0 cm (8.7 in). Superficial contact damage was documented on the right side surface which was attributed to the chain link fence impact. A small indentation was identified at the center portion of the front bumper from the guy wire impact. Minor damage was also noted to the front and center sections of the undercarriage from the landscaping wall impact. The windshield was fractured from exterior forces and (interior) occupant contact.

Interior Damage

Interior damage to the Nissan identified through the NASS vehicle inspection was minimal and was attributed to occupant contact **(Figure 4)**. A small indentation and scuff marks were documented to the driver knee bolster (rigid plastic type). The turn signal arm affixed to the steering column was deformed. Blood spattering was noted on the face of the driver air bag along with spattering to the lower left quadrant of the passenger air bag. Two small spider-web type fractures were identified at the left windshield area. The glove compartment door was found open and deformed along with a scuff mark to the right knee bolster. No deformation was noted to the steering wheel rim (tilt column set to the center position). Intrusions into the front right passenger space included 32.0 cm (12.6 in) of longitudinal toepan intrusion, 8.0 cm (3.1 in) of longitudinal instrument panel intrusion and 3.0 cm (1.2 in) of lateral door panel intrusion.

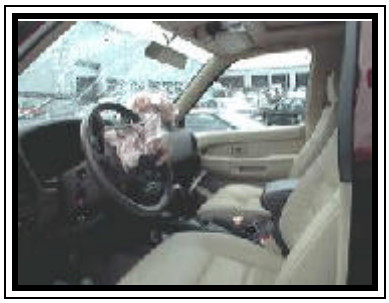

Figure 4. Interior view.

REDESIGNED AIR BAG SYSTEM

The 1998 Nissan Pathfinder was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were asymmetrical in shape as the upper flap measured 14.0 cm (5.5 in) in width and 10.0 cm (3.9 in) in height while the lower flap measured 14.0 cm (5.5 in) in width and 8.0 cm (3.1 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was noted on the upper and lower sections the air bag which was attributed to the driver's hand injury. The NASS researcher measured the diameter of the driver air bag at 62.0 cm (24.4 in) in its deflated state **(Figure 5)**. The bag was tethered by two internal straps and vented by two ports located at the 10 o'clock and 2 o'clock sectors on the rear aspect of the air bag.

Figure 5. 1998 Nissan Pathfinder redesigned driver air bag.

The front right passenger air bag deployed from a top mount module in the right instrument panel with a horizontally oriented flap tear seam (H-configuration). The cover flaps were rectangular in shape as the

upper flap measured 28.0 cm (11.0 in) in width and 7.0 cm (2.8 in) in height while the lower flap measured 28.0 cm (11.0 in) in width and 5.0 cm (2.0 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was noted to the lower left quadrant of the air bag which could be attributed to the driver's right hand injury or an unreported bloody nose sustained by the passenger. The NASS researcher measured the passenger air bag at 70.0 cm (27.6 in) in width and 58.0 cm (22.8 in) in height in its deflated state **(Figure 6)**. No internal tether straps were present. The bag was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. No cutoff switch was reported for the front right air bag.

Figure 6. 1998 Nissan Pathfinder redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	38 year old female
Height:	170 cm (67 in)
Weight:	64 kg (140 lb)
Seat Track Position:	Middle position
Manual Restraint Use:	None
Usage Source:	NASS vehicle inspection, driver interview, medical report
Eyeware:	Sunglasses (undamaged in crash)
Type of Medical Treatment:	Transported to a local hospital for treatment and admitted (4 days)

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
Compression fracture of the thoracic spine at T-3	Moderate (650432.2,7)	Front left air bag (indirect contact injury)
Abrasion posterior right hand	Minor (790202.1,1)	Windshield (air bag related fling injury)
Contusion mid-chest	Minor (490402.1,4)	Front left air bag

Driver Kinematics

The 38 year old female driver of the 1998 Nissan Pathfinder was unrestrained and presumed to be seated out-of-position forward and to the right due to the seizure. The seat back was slightly reclined and the seat track was adjusted to the middle position. Lack of belt usage was confirmed by the type of injuries sustained and contact points within the vehicle.

At impact with the mailbox post, landscaping wall (and chain link fence), she probably remained in her pre-impact posture as these minor impacts offered no significant resistance to the vehicle or produce any resulting kinematic response from the occupant. At impact with the utility pole, she initiated a forward trajectory in response to the 12 o'clock impact force as the expanding air bag propelled her hands upward into the windshield resulting in an abrasion to the right posterior hand, evidenced by the spider-web type fractures documented to the left windshield area. She subsequently loaded the deployed redesigned driver air bag which resulted in a contusion to the mid-chest. Since the driver was suffering from a diabetic seizure, she was out-of-position and probably further displaced by the guy wire impact. Therefore, when the air bag deployed, she may have been in an awkward position or in the path of the air bag. The deploying redesigned air bag probably expanded against the driver's chest and/or shoulder area which resulted in a compression fracture of T-3. Although compression fractures typically result from bottoming type impacts, there was no substantial undercarriage contact to induce such motion. The air bag provided restraint against further contact to the steering wheel hub/rim. The driver was transported to a local hospital for treatment and admitted for four days.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	11 year old male
Height:	145 cm (57 in)
Weight:	41 kg (90 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, police report
Eyeware:	None
Type of Medical Treatment:	None

Front Right Passenger Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Contusion forehead	Minor (290402.1,7)	Front right air bag

Front Right Passenger Kinematics

The 11 year old male front right passenger of the 1998 Nissan Pathfinder was restrained by the available 3-point lap and shoulder belt system, seated out-of-position towards the driver in attempts of reviving her out of an unconscious state. The seat back was slightly reclined with the seat track adjusted to the full rearward position. Belt usage was confirmed by the lack of significant interior contact points and occupant injury.

At impact with the mailbox post, landscaping wall (and chain link fence), he probably remained in his pre-impact posture as these minor impacts offered no significant resistance to the vehicle or produce any resulting kinematic response from the occupant. At impact with the utility pole, he initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and redesigned passenger air bag. Contact to the deployed air bag resulted in a contusion to the forehead

as evidenced by the location of the injury relative to the rearward extent of the deployed air bag. Given the occupant's pre-impact posture (with possible further displacement by the guy wire impact) and associated hand placement on the driver, it is probable that the air bag propelled the hand back into the face resulting in an (air bag indirect) forehead contusion. In addition, a possibility exists that this mechanism may have also contributed to an (unreported) bloody nose, evidenced by the size and location of the blood spattering to the lower left section of the air bag. The front right passenger was not transported for treatment but accompanied his mother to the hospital.

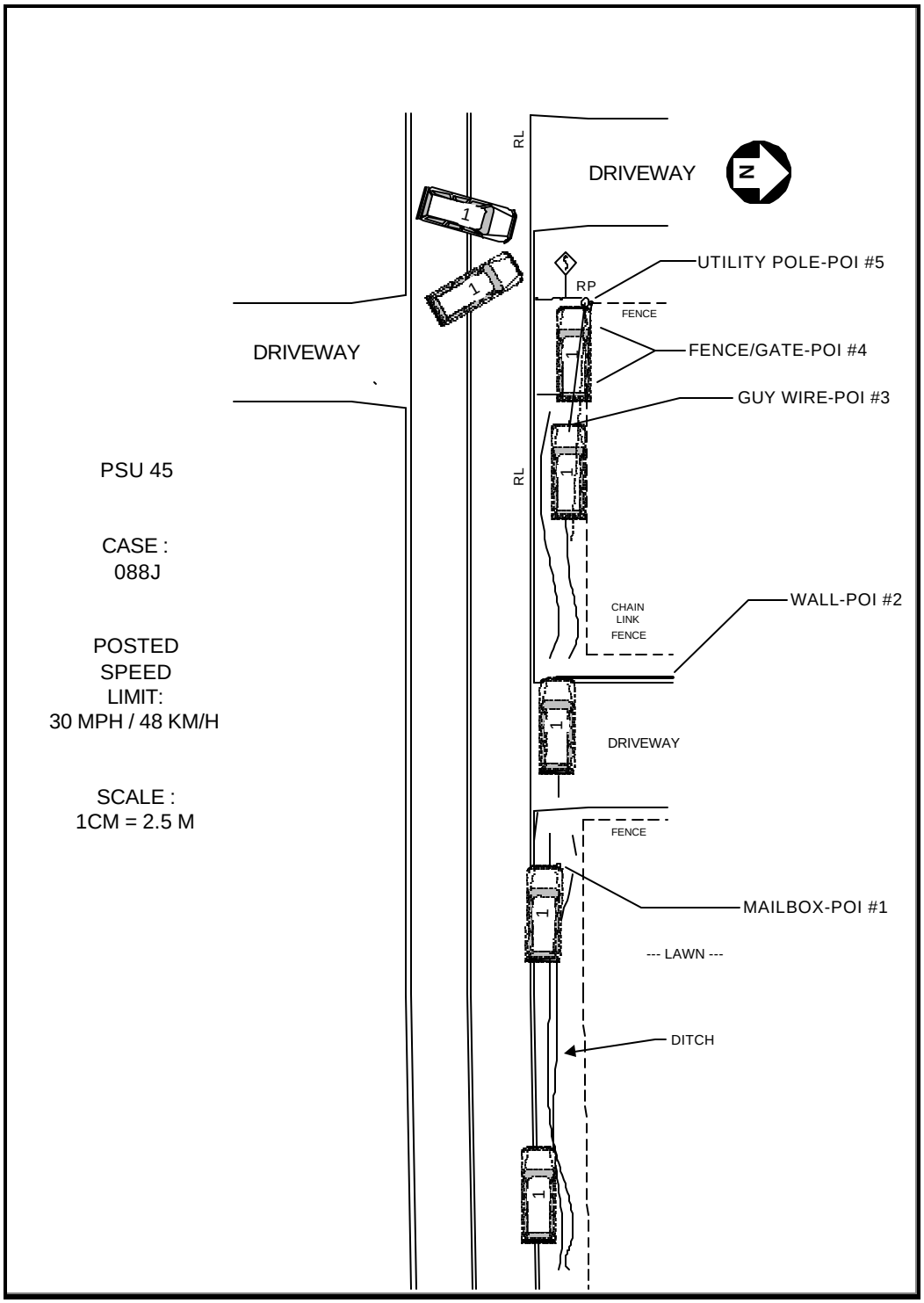

Figure 7. NASS Scene Diagram