TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS CDS CASE NO. 1998-45-160C

RABSS VEHICLE - 1998 NISSAN SENTRA XE

LOCATION - STATE OF TENNESSEE

CRASH DATE - NOVEMBER, 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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16. *Abstract* This investigation focused on a two vehicle crash involving a 1998 Nissan Sentra XE 4-door sedan (subject vehicle) and a 1998 Ford Expedition XLT sport utility vehicle. The Nissan Sentra was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an acute angle collision with the Ford Expedition. The driver of the Ford was operating the vehicle eastbound and negotiating a left curve on wet pavement when the vehicle began to rotate counterclockwise and subsequently crossed the center line into the path of the westbound Nissan. As the Ford entered the westbound lane, the front left area of the Nissan impacted the right rear side surface of the Ford resulting in moderate damage to both vehicles. The restrained 51 year old male driver of the Nissan Sentra initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in contusions of the left shoulder and chest. He also sustained multiple soft tissue injuries to the knees from contact to the knee bolster. Both drivers were transported to a local hospital for treatment and released.			
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BACKGROUND

This investigation focused on a two vehicle crash involving a 1998 Nissan Sentra XE 4-door sedan (subject vehicle) and a 1998 Ford Expedition XLT sport utility vehicle. The Nissan Sentra was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an acute angle collision with the Ford Expedition. The driver of the Ford was operating the vehicle eastbound and negotiating a left curve on wet pavement when the vehicle began to rotate counterclockwise and subsequently crossed the center line into the path of the westbound Nissan. As the Ford entered the westbound lane, the front left area of the Nissan impacted the right rear side surface of the Ford resulting in moderate damage to both vehicles. The restrained 51 year old male driver of the Nissan Sentra initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in contusions of the left shoulder and chest. He also sustained multiple soft tissue injuries to the knees from contact to the knee bolster. Both drivers were transported to a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 98-45-160C and 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 the task of case review and final report preparation.

SUMMARY

Crash Site

This two vehicle crash occurred during the morning hours of November, 1998. At the time of the crash, it was daylight with rainy conditions as the roads were wet. The crash occurred in the westbound lane of a level/asphalt two lane east/west county route **(see Figure 8 - page 5)** which curved left for eastbound traffic. *"Slick pavement"* and curve warning signs were present at the scene which had a posted speed limit of 64 km/h (40 mph).

Pre-Crash

The 33 year old male driver of the 1998 Ford Expedition was operating the vehicle eastbound and reportedly accelerating out of a left curve **(Figure 1)** when the vehicle began to fishtail on the wet pavement. The Ford driver reported no avoidance maneuvers as the vehicle rotated counterclockwise into the opposing westbound lane. The 51 year old male driver of the 1998 Nissan Sentra was operating the vehicle westbound **(Figure 2)** at a (driver reported) speed of 48 km/h (30 mph) when he observed the eastbound Ford encroach into his lane of travel. Upon recognition of the impending harmful event, he braked in avoidance remaining in the westbound lane prior to the collision.

Figure 1. Eastbound approach for the 1998 Ford Expedition.

Figure 2. Westbound approach for the 1998 Nissan Sentra.

Crash

As the Ford Expedition entered the westbound lane of the rural two lane roadway, the front left area of the Nissan Sentra impacted the right rear side surface of the Ford resulting in moderate damage to both vehicles. *Although the input data was questionable*, the damage algorithm of the WinSMASH program computed velocity changes of 17.9 km/h (11.1 mph) for the subject vehicle and 9.0 km/h (5.6 mph) for the struck Ford Expedition. Respective longitudinal components were -15.5 km/h (-9.6 mph) and -5.8 km/h (-3.6 mph). The impact induced deceleration was sufficient to deploy the Nissan's redesigned frontal air bag system. The Nissan Sentra came to rest in the westbound lane facing northwest as the Ford Expedition came to rest off the north shoulder facing northeast.

Post-Crash

The driver of the Nissan Sentra was removed from the vehicle with perceived serious injuries as the driver of the Ford Expedition exited the vehicle under his own power. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The driver of the Nissan was transported by ambulance to a local hospital for treatment and released. The driver of the Ford was transported by private vehicle to a local hospital for treatment and released. Both vehicles were towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Nissan Sentra XE was identified by the Vehicle Identification Number (VIN): 1N4AB41D2WC (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 1.6 liter, 4 cylinder engine. The vehicle's odometer reading was 21,610 km (13,428 miles) at the time of the crash. The driver was listed on the police report as the owner of the vehicle. The seating was configured with front bucket and rear bench seats. 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

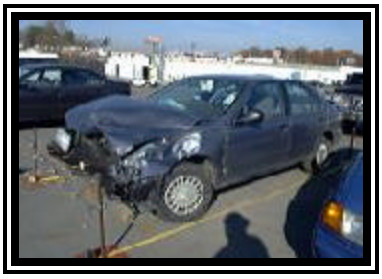

Figure 3. Frontal damage to the 1998 Nissan Sentra XE.

The 1998 Nissan Sentra XE sustained moderate frontal damage as a result of the impact with the Ford Expedition **(Figure 3)**. The direct contact damage began at the front left bumper corner and extended 126.0 cm (49.6 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 138.0 cm (54.3 in). Six crush measurements were documented at the level of the reinforcement bar *(bumper fascia separation)*: C1= 8.0 cm (3.1 in), C2= 30.0 cm (11.8 in), C3= 24.0 cm (9.4 in), C4= 14.0 cm (5.5 in), C5= 2.0 cm (0.8 in), C6= 0 cm. The Collision Deformation Classification (CDC) for this impact to the Nissan Sentra was 11-FDEW-2 with a principal direction of force of (-)30 degrees. A wheel imprint was noted to the reinforcement bar attributed to the right rear wheel of the Ford. The left fender was deformed rearward which restricted the left front wheel/tire (not deflated). The hood was deformed up and rearward from engagement against the side surface of the Ford. The windshield was fractured from exterior impact forces (only).

Figure 4. Right rear side surface damage to the 1998 Ford Expedition.

The 1998 Ford Expedition XLT sport utility vehicle sustained moderate right rear side surface damage as a result of the impact with the Nissan Sentra **(Figure 4)**. The direct *(and induced)* contact damage began 70.0 cm (27.6 in) forward of the right rear axle and extended rearward 162.0 cm (63.8 in). The CDC for this impact to the Ford Expedition was 02-RZEW-2 with a principal direction of force of (+)50 degrees. A maximum crush value of 21.0 cm (8.3 in) was identified aft of the right rear axle with direct contact damage noted to the right rear wheel (deflated not restricted).

Interior Damage

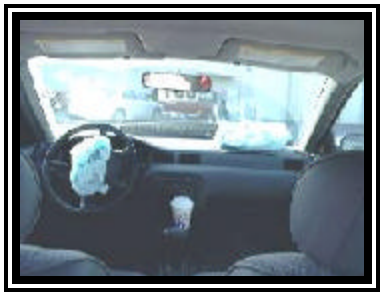

Figure 5. Interior view of the 1998 Nissan Sentra.

Damage to the interior surfaces of the Nissan Sentra were minimal and attributed to occupant contact **(Figure 5)**. Scuff marks were documented on the left knee bolster (rigid plastic). No intrusions were found in the vehicle.

REDESIGNED AIR BAG SYSTEM

The 1998 Nissan Sentra 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 11.0 cm (4.3 in) in height while the lower flap measured 14.0 cm (5.5 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, small scuff marks were documented to the upper left quadrant of the air bag. The NASS researcher measured the diameter of the driver air bag at 50.0 cm (19.7 in) in its deflated state **(Figure 6)**. The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.

The front right passenger air bag deployed from the right top instrument panel area with a horizontally oriented flap tear seam (H-configuration). No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The flaps were nearly symmetrical in shape as the forward flap measured 25.0 cm (9.8 in) in width and 8.0 cm (3.1 in) in height while the aft flap measured 25.0 cm (9.8 in) in width and 5.0 cm (2.0 in) in height. The NASS researcher measured the passenger air bag at 52.0 cm (20.5 in) in width and 55.0 cm (21.7 in) in height in its deflated state **(Figure 7)**. 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 passenger air bag.

Figure 6. 1998 Nissan Sentra redesigned driver air bag.

Figure 7. 1998 Nissan Sentra redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	51 year old male
Height:	180 cm (71 in)
Weight:	97 kg (214 lb)
Seat Track Position:	Mid-to-rear 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:	Transported to a local hospital and released

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Contusion left shoulder	Minor (790402.1,2)	Shoulder belt webbing
Contusion left chest	Minor (490402.1,2)	Shoulder belt webbing
Contusion bilateral knees	Minor (890402.1,3)	Knee bolster
Laceration right knee	Minor (890600.1,1)	Knee bolster
Abrasion right knee	Minor (890202.1,1)	Knee bolster

Driver Kinematics

The 51 year old male driver of the 1998 Nissan Sentra was properly restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-rear position. His hands were placed at the 10 o'clock and 2 o'clock positions on the steering wheel rim. Belt usage was confirmed by the lack of significant interior contacts and injury. At impact, the driver initiated a forward trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in contusions to the left shoulder and chest as evidenced by the size and location of the injury relative to the driver's reported placement of the shoulder harness. Contact to the deployed driver air bag was evidenced by the scuff marks identified on the upper left quadrant of the air bag face. He also sustained multiple soft tissue injuries to both knees from contact to the knee bolster, evidenced by the scuff marks documented to this component. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury. The driver was transported by ambulance to a local hospital for treatment and released.

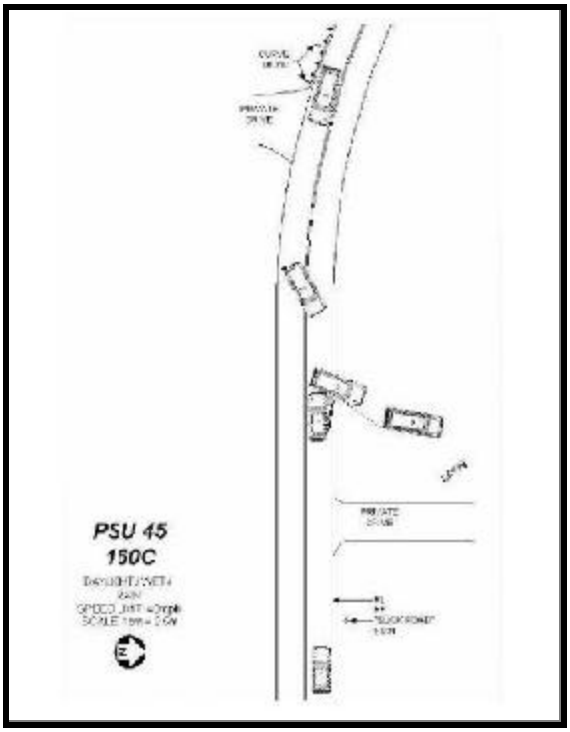

Figure 8. NASS Scene Diagram.