

**CRASH DATA RESEARCH CENTER**

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**CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE**

**CRASH INVESTIGATION**

**SCI CASE NO.: CA08021**

**VEHICLE: 2008 NISSAN SENTRA**

**LOCATION: PENNSYLVANIA**

**CRASH DATE: MAY 2008**

Contract No. DTNH22-07-C-00043

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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 Certified Advanced 208-Complaint (CAC) frontal air bag system and the source of injuries for a restrained 25-year old female driver of a 2008 Nissan Sentra. The Sentra was equipped with a CAC frontal air bag system and a side impact system that consisted of seat back mounted side impact air bags and curtain air bags. Additionally, the Nissan was equipped with retractor mounted pretensioners for the front safety belts. The manufacturer of this vehicle has certified that the Sentra is compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard No. 208. The driver reportedly was reaching for a cellular telephone and lost directional control of the vehicle. The Nissan departed the right road edge and struck a metal overhead sign pole. As a result of the crash, the driver's frontal air bag, right seat back mounted air bag, and the right curtain air bag deployed. The front safety belt pretensioners actuated in conjunction with the air bag deployment. The driver was hospitalized for four days with severe injuries.					
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**BACKGROUND**

This on-site investigation focused on the Certified Advanced 208-Complaint (CAC) frontal air bag system and the source of injuries for a restrained 25-year old female driver of a 2008 Nissan Sentra (**Figure 1**). The Sentra was equipped with a CAC frontal air bag system and a side impact system that consisted of seat back mounted side impact air bags and curtain air bags. Additionally, the Nissan was equipped with retractor mounted pretensioners for the front safety belts. The manufacturer of this vehicle has certified that the Sentra is



**Figure 1. 2008 Nissan Sentra.**

compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard No. 208. The driver reportedly was reaching for a cellular telephone and lost directional control of the vehicle. The Nissan departed the right road edge and struck a metal overhead sign pole. As a result of the crash, the driver's frontal air bag, right seat back mounted air bag, and the right curtain air bag deployed. The front safety belt pretensioners actuated in conjunction with the air bag deployment. The driver hospitalized for four days with severe injuries.

The crash was identified from a group of PARS that were forwarded to NHTSA by the Calspan Special Crash Investigations (SCI) team. These PARS were obtained through the sampling activities of the National Automotive Sampling System (NASS). The Calspan SCI team contacted the insurance adjustor and located the Nissan at a local insurance salvage yard. Due to the Agency's interest in vehicles with CAC systems the crash was assigned as an on-site investigation on June 6, 2008. Cooperation to inspect the vehicle was secured and the on-site aspect of this investigation was conducted on June 10, 2008. An electronic scan tool was requested from Nissan North America to download the hexadecimal codes from the Sentra's Event Data Recorder (EDR). However, due to vehicle damage, the download was not successful.

**SUMMARY**

***Crash Site***

The crash occurred on the south road side of a five-lane road during nighttime hours of May 2008. The east/west travel lanes were surfaced with asphalt and were separated by a painted median. The median transitioned to a left turn only lane for eastbound traffic in the area of the crash site. The eastbound travel lanes contained a left curve that ended

near the crash site. A paved shoulder was adjacent to the eastbound travel lanes and a concrete curb bordered the west road edge. Utility poles, a grass embankment, and a tree line extended beyond the east shoulder. The stuck pole was a metal overhead sign pole that was mounted to a concrete base. The diameter of the struck pole was 32 cm (12.6”) and was located 0.3 meters (1 foot) south of shoulder. The posted speed limit was 40 km/h (25 mph). At the time of the crash, the weather conditions were clear, dark, and dry. The Scene Schematic is included as **Figure 8** of this report.

***Vehicle Data***

The case vehicle in this crash was a 2008 Nissan Sentra four-door sedan. The Nissan was manufactured in 08/07 and was identified by Vehicle Identification Number (VIN) 3N1A861E88L (production number deleted). The Sentra was powered by a 2.0-liter, transverse mounted 4-cylinder engine linked to a Continuously Variable Transmission (CVT) with a console mounted shift lever. The service brakes were power-assisted front disc/rear drum. The tires were Bridgestone Turanza, size P205/60R15 mounted on OEM steel wheels. The vehicle manufacturer recommended front and rear cold tire pressure was 228 kPa (33 PSI). The tire data at the time of the SCI inspection was as follows:

<b>Position</b>	<b>Measured Pressure</b>	<b>Measured Tread Depth</b>	<b>Damage</b>
Left Front	214 kPa (31 PSI)	6 mm (8/32”)	None
Right Front	214 kPa (31 PSI)	7 mm (9/32”)	None
Left Rear	214 kPa (31 PSI)	8 mm (10/32”)	None
Right Rear	221 kPa (32 PSI)	7 mm (9/32”)	None

The interior of the Nissan was configured for five-passenger seating with front bucket seats and a rear bench with split folding backs. The four outboard positions were equipped with adjustable head restraints that were in the full down positions. The seat surfaces were cloth. The vehicle was equipped with power windows, power door locks, and a tilt steering column that was located in the full-up position at the time of the SCI inspection. The steering wheel was configured with three spokes at the 3, 9, and 6 o’clock positions.

***Crash Sequence***  
***Pre-Crash***

The 25-year old female driver of the Nissan was traveling in an easterly direction on the outboard lane negotiating the left curve (**Figure 2**). The driver stated that while she was negotiating the left curve, she reached for her cellular phone that had fallen onto the floor. While reaching for the phone, the vehicle continued on a straight path within the left curve and departed the right travel lane. The vehicle traversed the 3.6 meter (11.8 feet) wide asphalt shoulder and entered the roadside.



**Figure 2. Nissan's pre-crash approach.**

### ***Crash***

The front right aspect of the vehicle impacted and sheared a metal overhead sign pole (**Figure 3**) that was located 0.3 meters (1 foot) outboard of the shoulder. The replacement pole was mounted to a concrete base that extended above the ground approximately 5 cm (2"). Additionally, a sheared wooden utility was located near the crash site. This pole was not contacted by the Nissan. The direction of force was 12 o'clock for this fixed object impact. The barrier equivalent algorithm of the WINSMASH program was used to calculate a delta-V for this impact. The calculated Barrier Equivalent Speed (BES) was 48 km/h (30 mph). The impact actuated the front retractor mounted safety belt pretensioners and deployed the driver's frontal air bag, the right seat back mounted air bag, and the right curtain air bag.



**Figure 3. Area of impact with the utility pole.**

As a result of the impact, the Nissan rotated clockwise approximately 170 degrees and came to final rest on the roadside facing a westerly direction. The final rest of the vehicle was estimated based on the evidence that was present within the crash area. This evidence included vehicle parts that consisted of the grille, right head light, and bumper foam from the Nissan.

### ***Post-Crash***

Police and emergency personnel responded to the crash site. The driver was found outside of the vehicle; however, her form of egress was not known. The driver sustained severe injuries and was transported to a hospital for treatment. The Nissan was deemed a total loss by the insurance company and was transferred to a salvage facility.

### ***Vehicle Damage***

#### ***Exterior***

The 2008 Nissan Sentra sustained severe damage to the front plane as a result of the impact with the pole (**Figures 4 and 5**). The damaged components included, but were not limited to, the bumper fascia, bumper beam, hood, right fender, and the right front suspension components. The impact occurred inboard of the front right frame rail. The direct contact damage was measured on the hood which began 16 cm (6.3") right of the vehicle's centerline and extended 32 cm (12.4") to the right. The total length of direct contact damage was 32 cm (12.4").

The maximum crush measured 68 cm (26.7") and was located 36 cm (14.2") right of the centerline. A crush profile was documented along the bumper beam which was as follows: C1 = 0 cm, C2 = 10 cm (3.9"), C3 = 27 cm (10.6"), C4 = 44 cm (17.3"), C5 = 64 cm (25.2"), C6 = 55 cm (21.7").

The front right impact reduced the right wheelbase by 8 cm (3.1”) and elongated the left wheelbase by 5 cm (2”). The Collision Deformation Classification (CDC) for the pole impact was 12-FZEN-3

All four doors remained closed during the crash and were operational post-crash. The windshield was fractured at the base from contact with the hood edge. The side and rear glass were intact. The left rear bumper corner exhibited damage in the form of abrasions. This damage did not appear to be related to this crash sequence.



**Figure 4. Overall view of the frontal damage.**



**Figure 5. Overhead view of the frontal crush.**

***Interior***

The interior of the Nissan sustained moderate severity damage as a result of passenger compartment intrusion and driver contact.

The left knee bolster and center console sustained loading damage from occupant contact. The driver’s left knee struck the knee bolster left of the centerline resulting in slight deformation to the rigid plastic panel. The right knee also contacted the bolster, right of the centerline. This contact was evidenced by deformation and a fracture to the rigid plastic knee bolster panel. The driver’s right leg contacted the center console which separated the trim panel that was positioned over the transmission selector. Additionally, this contact displaced the lower trim panel for the center instrument panel.

The passenger compartment intrusions identified during the SCI inspection are outlined below:

<b>Location</b>	<b>Component</b>	<b>Magnitude</b>	<b>Direction</b>
Front Right	Toe pan	3 cm (1.2”)	Longitudinal
Front Right	Instrument panel	2 cm (0.8”)	Longitudinal

***Certified Advanced 208-Compliant Frontal Air Bag System***

The 2008 Nissan Sentra was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front right passenger positions. The manufacturer of this vehicle has certified that the Sentra is compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard No. 208. This system consisted of

dual-stage frontal air bags, seat track position sensors, safety belt buckle switch sensors, a front right passenger weight sensor, and front safety belt retractor pretensioners.

The driver's air bag (**Figure 6**) was concealed in the center hub of the three-spoke steering wheel by asymmetrical cover flaps. The top flap was 14 cm (5.5") in width at the horizontal tear seam and 9 cm (3.5") in height. The two lower flaps measured 8 cm (3.1") in width and 6 cm (2.4") in height. The air bag membrane was 59 cm (23.2") in diameter in its deflated state. The air bag was vented by two vent ports located at the 11 and 1 o'clock positions.

The driver's face contacted the deployed air bag membrane which was evidenced by make-up transfers. These contacts consisted of two black colored mascara (eye make-up) transfers and a large beige colored (make-up) transfer. The transfers from the left and right eye were located 11 cm (4.3") 13 cm (5.1") from the top seam, respectively. Inboard from the left seam, the left and right eye transfers were located from 1-3 cm (0.4-1.2") and 7-9 cm (2.8-3.5"), respectively.



**Figure 6. Deployed driver's frontal air bag.**

The front right air bag was mounted within the top aspect of the right instrument panel. The front right seat was not occupied during the crash; therefore, the CAC system suppressed the deployment of the air bag, as designed.

#### ***Event Data Recorder***

The Nissan was equipped with an air bag control module that had Event Data Recording (EDR) capabilities. The Nissan Consult II Diagnostic Scan Tool was obtained from Nissan to download the EDR during the SCI investigation. The SCI investigator followed the procedures provided by Nissan to connect to the vehicle's Diagnostic Link Connector (DLC). The SCI investigator made several attempts to retrieve the EDR data. A Nissan engineer was contacted from the field and was provided a description of the vehicle damage and issues related to the download. It was determined that the electrical system had been damaged as 12 volt power could not be transmitted into the DLC; therefore, the recorded data could not be downloaded.

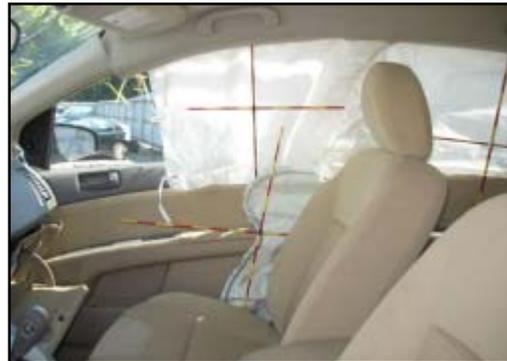
#### ***Side Impact Air Bag System***

The Nissan was equipped with front seat back mounted side impact air bags and roof side rail mounted curtain air bags. The right seat back mounted air bag and the right curtain air bag deployed during the crash; the left side air bags did not deploy.

The right seat back mounted air bag was concealed within the outboard aspect of the seat back and consisted of two panels sewn together at the forward edge. The air bag deployed through a 42 cm (16.5") tear seam at the forward aspect of the seat back. The air bag membrane measured 56 cm (22.0") in height. The membrane extended forward in

an asymmetrical pattern. The top portion measured 32 cm (12.6”) in width and the bottom measured 36 cm (14.2”) in width. The air bag membrane contained a single vent port that was located on the top edge and measured 5 cm (2.0”) in height and 4 cm (1.6”) in width. The air bag membrane was not damaged and did not contain occupant loading evidence.

The right curtain air bag deployed from the roof side rail. The air bag membrane measured 153 cm (60.2”) in length. The air bag was tethered to the A- and C-pillars. The A-pillar tether was cut post-crash; however, it measured 53 cm (20.9”) in length. The C-pillar tether measured 7 cm (2.8”) and was also cut post-crash. At the front seating position, the membrane measured 45 cm (17.7”) in height, extending to 10 cm (3.9”) below the top of the door panel. The curtain air bag overlapped the seat back mounted air bag by 11 cm (4.3”) in its deflated state. As designed, the curtain air bag left a triangular shaped void at the front position which measured 37 cm (14.6”) in height and 46 in (18.1”) length. The height of the curtain air bag membrane at the right rear position was 44 cm (17.3”) and extended 12 cm (4.7”) below the top of the door panel. Vertically, the air bag membrane provided coverage to the belt line; however, due to the void near the A-pillar, complete longitudinal coverage across the front glazing was not available.



**Figure 7. Front right curtain air bag and the seat back mounted side impact air bag.**

The right curtain air bag did not contain occupant loading evidence. Post-crash damage was present to the outboard aspect of the air bag membrane. This damage consisted of two diagonally oriented cuts to the membrane at the right rear position that measured approximately 15 cm (6.0”). **Figure 7** depicts the front right curtain air bag and the seat back mounted side impact air bag.

### ***Manual Safety Belt Systems***

The safety belt systems consisted of continuous loop webbing and sliding latch plates for all five positions. The front belts were equipped with adjustable D-rings and retractor mounted pretensioners. The D-rings were adjusted to the full-up position. The driver’s retractor was equipped with an Emergency Locking Retractor (ELR).

The driver did not use the safety belt during the crash, which was supported by the actuated pretensioner that locked the safety belt against the B-pillar in the stowed position. The kinematics of the driver further supported her unrestrained status.

The front right and rear seat retractors were switchable from the ELR to the Automatic Locking Retractor (ALR) mode. Although the front right seat was not occupied, the front right safety belt retractor actuated during the crash, cinching the safety belt taught against the B-pillar.

***Driver Demographics/Data***

Age/Sex: 25-year old/Female  
Height: Unknown  
Weight: 50 kgs (110 lbs)  
Seat Track Position: Unknown  
Eyewear: Unknown  
Manual Safety Belt Use: None used  
Usage Source: SCI vehicle inspection  
Driver Egress from Vehicle: Unknown  
Mode of Transport  
From Scene: Ground ambulance to a hospital, transferred by a helicopter to a trauma center  
Type of Medical Treatment: Hospitalized

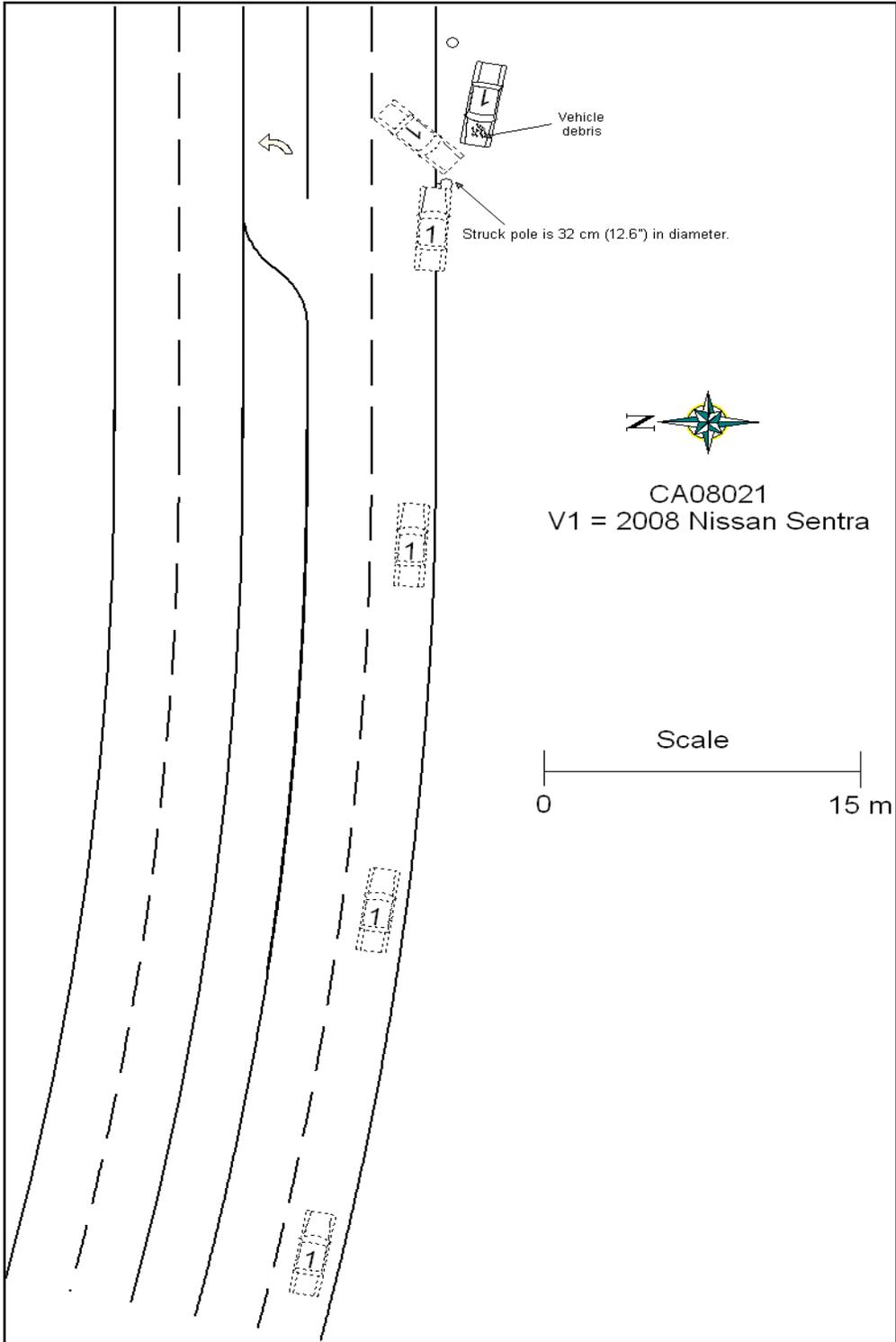
***Driver Injuries***

<b>Injury</b>	<b>Injury Severity (AIS 90/Update 98)</b>	<b>Injury Source</b>
Large rupture of the spleen	Severe (544226.4,2)	Steering wheel rim
Small abrasion to the upper left quadrant of the abdomen	Minor (590202.1,2)	Steering wheel rim
Abrasions to the right knee and bilateral lower extremities	Minor (890202.2,3)	Knee bolster
Small abrasions to the right ankle	Minor (890202.1,1)	Brake pedal

***Driver Kinematics***

The 25-year-old female driver of the Nissan was seated in a unknown-track position with the seat back reclined 25 degrees aft of vertical and the head restraint adjusted to the full-down position. The seat track was found adjusted to the full-rear position at the time of the SCI inspection. She was not restrained by the manual safety belt system. The lack of belt usage was supported by the actuated status of the retractor pretensioner which locked the safety belt in the stowed position.

At impact, the driver's pretensioner actuated and the frontal air bag deployed. The driver initiated a forward trajectory in response to the 12 o'clock direction of force. The driver's face contacted the deploying air bag which resulted in the make-up transfers on the air bag membrane. Her knees contacted the knee bolster and the center console resulting in the abrasions to the lower extremities. Her abdomen loaded through the bottom of the deployed air bag and engaged the steering wheel rim. This contact resulted in the large rupture of the spleen. Additionally, the driver sustained abrasions to the right ankle from contact with the brake pedal. The driver was transported by ground ambulance to a local hospital where she was stabilized and transferred by helicopter to a trauma center. At the trauma center, the driver underwent an exploratory laparotomy to observe the spleen rupture. She was hospitalized for four days and was released.



**Figure 8: Scene Schematic**