CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION CRASH INVESTIGATION

SCI CASE NO: – CA08013

VEHICLE – 2007 NISSAN SENTRA

LOCATION – STATE OF VIRGINIA

CRASH DATE – FEBRUARY 2008

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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 investigative effort focused on the side impact inflatable occupant protection system in a 2007 Nissan Sentra and the injury sources of the 26-year-old female driver. The Nissan was equipped with seat back mounted side impact air bags for the front seat positions and curtain air bags for the four outboard positions. The Nissan was not equipped with rollover sensing. The Nissan was involved in an intersection crash with a 1993 Ford Taurus. As a result of the crash, the left seat back mounted side impact air bag and the left side curtain air bag deployed. It was police reported that the driver of the Nissan sustained visible injuries and was transported to a hospital where she was treated and released.			
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BACKGROUND

This on-site investigative effort focused on the side impact inflatable occupant protection system in a 2007 Nissan Sentra **(Figure 1)** and the injury sources of the 26-year-old female driver. The Nissan was equipped with seat back mounted side impact air bags for the front seat positions and curtain air bags for the four outboard positions. The Nissan was not equipped with rollover sensing. The Nissan was involved in an intersection crash with a 1993 Ford Taurus. As a result of the crash, the left seat back mounted side impact air bag and the left side curtain air bag deployed. It was police reported that the driver of the Nissan sustained visible injuries and was transported to a hospital where she was treated and released.

Figure 1. 2007 Nissan Sentra.

This crash was identified through the review of General Estimate System (GES) Police Accident Reports (PAR). The Calspan Special Crash Investigations (SCI) team forwarded the PAR to the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) due to the deployed side impact protection system and the case was subsequently assigned as an on-site investigation on April 2, 2008. The Nissan was located at a salvage facility and cooperation was established to inspect the vehicle. The on-site investigation was conducted on April 8, 2008. A request for medical records was submitted to the treating hospital; however, the request was denied due to the lack of a signed medical release from the driver. Attempts to contact the driver were made via telephone calls and in-person. The attempts were not successful.

SUMMARY

Crash Site

This crash occurred during the evening hours of February 2008 at a four-leg intersection. The north/southbound legs of the intersection consisted of four-travel lanes, two in each direction, that were separated by broken white lane lines. The northbound travel lanes contained a left curve and a slight uphill grade which ended beyond the intersection. Double yellow center lines separated the north/southbound traffic flow. The total width of the north/south roadway was 16.1 meters (52.8 feet). The traffic lanes were bordered by 15 cm (6.0”) concrete curbs. Concrete sidewalks extended beyond the curbs. The east leg of the intersection consisted of one travel in each direction and served as an

entrance/exit to a business park. The width of the east leg was 7.7 meters (25.2 feet). The west leg was configured with one travel lane in each direction. The west leg measured 7.7 meters (25.2 feet) in width and was an entrance/exit to an apartment complex. A left curve was present for eastbound travel. The intersection was controlled by stop signs for the east/west traffic. The posted speed limit for both roadways was 56 km/h (35 mph). The scene schematic is included as **Figure 9** of this report.

Vehicle Data

2007 Nissan Sentra

The 2007 Nissan Sentra S, four-door sedan was manufactured in February 2007 and was identified by Vehicle Identification Number (VIN) 3N1A861E176 (production number deleted). The front wheel drive Sentra was powered by a 2.0 liter transverse mounted engine linked to a Continuously Variable Transmission (CVT). Additionally, the Nissan was equipped with power assisted front disc/rear drum brakes and a Tire Pressure Monitoring System (TPMS). The Sentra was not equipped with Electronic Stability Control or Traction Control systems. The Nissan was equipped with Bridgestone Turanza EL400 all-season tires mounted on seven-spoke OEM alloy wheels. The vehicle manufacturer recommended cold tire pressure was 228 kPa (33 PSI) for the front and rear. The specific tire data at the time of the SCI inspection of the Sentra was as follows:

Position	**Measured Tire Pressure**	**Measured Tread Depth**	**Tire/Wheel Damage**
Left Front	200 kPa (29 PSI)	6 mm (7/32”)	None
Left Rear	207 kPa (30 PSI)	6 mm (8/32”)	None
Right Front	83 kPa (12 PSI)	6 mm (8/32”)	None
Right Rear	214 kPa (31 PSI)	6 mm (8/32”)	None

The interior of the Sentra was configured with cloth surfaced five-passenger seating. The front bucket seats were separated by a center console and equipped with adjustable head restraints. Both front head restraints were adjusted to the full down positions. The rear seat was a split bench seat (60/40) with forward folding seat backs, right side wide. The outboard positions of the rear seat were equipped with adjustable head restraints, both adjusted to the full-down positions.

The interior occupant safety systems consisted of 3-point lap and shoulder belts for the five designated positions, dual stage frontal air bags, front seat back mounted side impact air bags, and Inflatable Curtain (IC) air bags that provided protection to the four outboard positions. This left side impact deployed the left seat back mounted air bag and the left IC. The Sentra did not have rollover sensing for the IC air bags.

1993 Ford Taurus

The 1993 Ford Taurus GL was a four-door sedan that was manufactured in March 1993. The VIN 1FACP52U0PA (production number deleted) identified the Taurus. The Taurus was powered by a 3.0 liter V-6 engine linked to a four-speed automatic transmission. The service brakes were power-assisted front disc/rear drum. The Taurus was equipped with Uniroyal Tiger Paw P205/70R14 all-season tires mounted on OEM steel wheels

concealed by plastic hubcaps. The vehicle manufacturer recommended cold tire pressure was 241 kPa (35 PSI). The specific tire data at the time of the SCI inspection was as follows:

Position	Measured Tire Pressure	Measured Tread Depth	Tire/Wheel Damage
Left Front	145 kPa (21 PSI)	3 mm (4/32”)	None
Left Rear	159 kPa (23 PSI)	3 mm (4/32”)	None
Right Front	152 kPa (22 PSI)	2 mm (3/32”)	None
Right Rear	165 kPa (24 PSI)	2 mm (3/32”)	None

The interior of the Taurus was configured with six-passenger seating, consisting of a split bench front seat and a rear bench seat. The front outboard positions were equipped with adjustable head restraints that were in the full-down positions. The safety systems consisted of lap and shoulder belts for the front outboard and the three rear positions. The center front seat was lap belt equipped. Supplemental protection was provided by a driver’s air bag system that deployed as a result of the intersection crash with the Nissan Sentra.

Crash Sequence

Pre-Crash

The unrestrained 26-year-old female driver of the Nissan Sentra was traveling east on the two-lane road as she was departing a residential complex **(Figure 2)**. She was decelerating for a regulatory stop sign and stopped at the mouth of the four-leg intersection. The driver did not to detect the southbound Ford Taurus and entered the intersection directly in the path of the Taurus.

The southbound Ford Taurus was driven by a 26-year-old female driver in the outboard travel lane on an approach to the intersection. It was her intention to travel straight through the intersection **(Figure 3)**. There were no traffic controls for the north and southbound traffic flow. As the driver of the Taurus detected the Nissan accelerate into her path of travel, she applied the brakes in an attempt to avoid the crash. The investigating officer noted in his report that there was tire/skid marks associated with the braking; however, these marks were not documented by the officer. These skid marks had eroded prior to the scene inspection by the SCI investigator.

Figure 2. Nissan's approach to the intersection.

Figure 3. Ford's northbound travel path.

Crash

The full frontal area of the Taurus impacted the left passenger side area of the Nissan. The direct contact damage was located on the doors and sill of the Nissan. The resultant directions of force were 1 o'clock for the Taurus and within the 10 o'clock sector for the struck Sentra. The left side doors of the Sentra were removed and discarded by a repair facility that conducted a damage estimate. Therefore, the crush was documented along the sill level and was used to calculate the delta V. The bumper fascia and bumper beam separated from the Ford during the crash. As a result of the missing bumper components, crush was measured at the frame rails and the upper radiator support. The average crush from these locations was used in the delta-V calculations. The damage algorithm of the WinSMASH program computed total velocity changes of 16 km/h (9.9 mph) for the Sentra and 14 km/h (8.7 mph) for the Taurus. The specific longitudinal and lateral components were -5 km/h (-3.1 mph) and 15 km/h (9.3 mph) for the Nissan. The longitudinal and lateral components for the Ford were -13 km/h (-8.1 mph) and -5 km/h (-3.1 mph).

Post-Crash

There was no physical evidence or police documentation to support the final rest positions of the vehicles. Based on the configuration and the directions of force, the Nissan was displaced laterally to its right and slightly forward as the Taurus continued forward and left to rest. Both vehicles sustained disabling damage and were towed from the crash site. The female driver's were transported by ambulance to a local hospital where they were treated for police reported incapacitating injuries.

Vehicle Damage

Exterior Damage – 2007 Nissan Sentra

The exterior of the Nissan Sentra sustained moderate severity damage as a result of the intersection crash **(Figure 4)**. The vehicle was towed to an auto body repair shop for a damage appraisal. At the body shop, the left side doors were removed for assessment of the damage to the left side structure. The front door hinges and the left rear lower door hinge were unbolted from the respective pillars. The upper rear door hinge was cut on the pillar side to remove the door. Both doors were discarded by the body shop prior to the assignment of this SCI investigation. The Nissan was subsequently deemed a total loss and was transferred to a regional salvage facility where it was inspected. The residual damage was measured at the sill level. The maximum crush measured 8 cm (3.1") and was located 107 cm (42.1") rear of the left front axle. The direct contact damage measured 124 cm (48.8") and began 83 cm (32.7") rear of the left front axle which extended 181 cm (71.3") rear of the reference point. The crush profile at this level and was as follows: C1 = 3 cm (1.2"), C2 = 6 cm (2.4"), C3 = 7 cm (2.8"), C4 = 8 cm (3.1"), C5 = 6 cm (2.4"), C6 = 0 cm. The Collision Deformation Classification (CDC) assigned for this crash was 10-LPEW-1.

Figure 4. Residual damage to the Nissan Sentra.

Interior

The 2007 Nissan Sentra sustained moderate severity interior damage that was attributed to passenger compartment intrusion. The left side doors were discarded post-crash; therefore, they could not be examined to determine occupant contact points or the extent of intrusion to these components. An occupant contact point was noted on the curtain air bag. This contact is described in the Side Impact Air Bag System of this report. The resultant intrusions are listed within the table below:

Location	Component	Magnitude	Direction
Left Front	Door	Approx. 5 cm (2.0”)	Lateral
Left Front	Sill	2 cm (0.8”)	Lateral
Left Front	Side panel forward of A-pillar	2 cm (0.8”)	Lateral
Left Front	Seat back	2 cm (0.8”)	Lateral
Left Front	Seat cushion	2 cm (0.8”)	Lateral
Center Front	Center console	2 cm (0.8”)	Lateral
Left Rear	Sill	4 cm (1.6”)	Lateral
Left Rear	Door Panel	Approx. 5 cm (2.0”)	Lateral

Exterior Damage

1993 Ford Taurus

The frontal area of the Taurus sustained moderate severity damage **(Figure 5)**. The bumper fascia and bumper beam separated from the vehicle during the crash. The direct contact damage extended across the full width of the Taurus and measured 142 cm (56”). Residual crush was documented at the frame rails and upper radiator support. The crush at the left and right frame rails measured 12 cm (4.7”) and 10 cm (3.9”), respectively. At the upper radiator support, the residual crush was as follows: C1 = 11 cm (4.3”), C2 = 13 cm (5.1”), C3 = 12 cm (4.7”), C4 = 15 cm (5.9”), C5 = 14 cm (5.5”), C6 = 13 cm (5.1”). The CDC for this damage was 01-FDEW-1.

Figure 5. Frontal damage to the Ford.

Manual Safety Belt Systems

2007 Nissan Sentra

The Nissan was equipped with manual 3-point lap and shoulder belts for the five designated seated positions. All belt systems utilized continuous loop webbing with sliding latch plates. The driver’s belt retracted onto an Emergency Locking Retractor (ELR) with a retractor pretensioner. The upper D-ring was adjustable and was set to the full-up position. The driver was not using the safety belt at the time of the crash, which was supported by the actuated retractor pretensioner that locked the safety belt taut in its stowed position against the left B-pillar.

The front right and three rear belt systems utilized switchable ELR and Automatic Locking Retractors (ALR). These positions were unoccupied at the time of the crash. In addition to the rear seat safety belts, the Sentra was equipped with Lower Anchors and Tethers for CHildren (LATCH). There were no child safety seats installed in the Sentra at the time of the crash.

Frontal Air Bag System
2007 Nissan Sentra

The Sentra was equipped with a Certified Advanced 208-Complaint (CAC) frontal air bag system that consisted of dual stage driver and passenger air bags, seat track positioning sensors, a front right occupant presence sensor, retractor pretensioners, and safety belt buckle switches. The manufacturer of this vehicle has certified that this Sentra is compliant to the advanced air bag portion of Federal Motor Vehicle Safety Standard (FMVSS) Number 208.

The driver's frontal air bag was conventionally mounted within the center of the three-spoke steering wheel rim. The front right air bag was mounted in the mid instrument panel. This side impact crash did not warrant the deployment of the driver's frontal air bag. The front right air bag was suppressed by the lack of a front right passenger and frontal impact.

Side Impact Air Bag System
2007 Nissan Sentra

The Sentra was equipped with front seat back mounted side impact air bags and roof side rail mounted curtain air bags. The left side crash deployed the driver's seat back air bag and the left curtain air bag.

Figure 6. Deployed left seatback mounted side impact air bag.

The left seat back mounted air bag was concealed within outboard aspect of the seat back. The air bag deployed through a 49 cm (19.3") tear at the forward seam of the seat back. The air bag membrane measured 43 cm (16.9") in height and 27 cm (10.6") in width and consisted of two panels sewn together at the forward edge. The height of the membrane resulted in overlapping height coverage with the curtain air bag. Three stitch patterns were sewn to the air bag membrane. These stitches were full width and were located 16 cm (6.3"), 18 cm (7.1"), and 20 cm (7.9"), receptively from the bottom of the air bag. These were probably designed to control the deployment path and inflation of the membrane. A single vent port was present at the forward edge, 4 cm (1.6") below the top of the air bag. The vent was port was located on the outboard aspect and measured 4 cm (1.6"). **Figure 6** is an overall view of the deployed left seat back mounted air bag.

The left curtain air bag deployed from the roof side rail. The air bag membrane measured 146 cm (57.5") in length. At the front left seating position, the membrane measured 43 cm (16.9") in height and 42 cm (16.5") in height at the left rear position. The air bag membrane covered the full height of the side glazing. The air bag was tethered at the A and C-pillars. The A-pillar tether was cut post-crash. It was unknown if the tether was cut by EMS or the repair facility. The tether measured 57 cm (22.4") in length. The C-pillar tether was 8 cm (3.1") in length. Longitudinally, the coverage area of this curtain air bag did not span across the left side glazing. A triangular shaped gap was present which began at the A-pillar and extended 46 cm (18.1") rearward. A probable occupant contact point was present on the curtain air bag which consisted of a reddish colored make-up transfer. This contact was located on the inboard aspect of the membrane 12-27 cm (4.7-10.6") rear of the forward edge and 6-15 cm (2.4-5.9") below the roof rail. **Figures 7 and 8** are images of the deployed curtain air bag and the occupant contact point.

Figure 7. Deployed left side curtain air bag.

Figure 8. Occupant contact on the left side curtain air bag.

Event Data Recorder

The 2007 Nissan Sentra was not equipped with a downloadable Event Data Recorder.

Occupant Demographics/Data

Driver Age/Sex:	26-year old female
Height:	Unknown
Weight:	Unknown
Eyewear:	Unknown
Seat Track Position:	Mid-track
Manual Safety Belt Use:	None Used
Usage Source:	Vehicle inspection
Egress from Vehicle:	Unknown
Mode of Transport From Scene:	Ambulance
Type of Medical Treatment:	Treated and released

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source

Visible injuries, NFS	Unknown	Unknown

Source = Police report

Driver Kinematics

The 26-year-old driver was seated in a mid-track position and was not restrained by the manual 3-point lap and shoulder belt system. The actuated pretensioner restricted the safety belt in stowed position. At impact with the Ford, the left seat back mounted air bag and left side curtain air bag deployed. The driver initiated a left trajectory in response to the 10 o'clock impact force and contacted the deployed side impact air bag system. This contact was supported by the transfer that was noted on the left curtain air bag. As a result of the crash, the driver sustained visible injuries and was transported to a hospital where she was treated and released.

A request for medical records was submitted to the treating hospital; however, the request was denied due to the lack of a signed medical release. Attempts to contact the driver were made via telephone calls and in-person. The attempts were not successful.

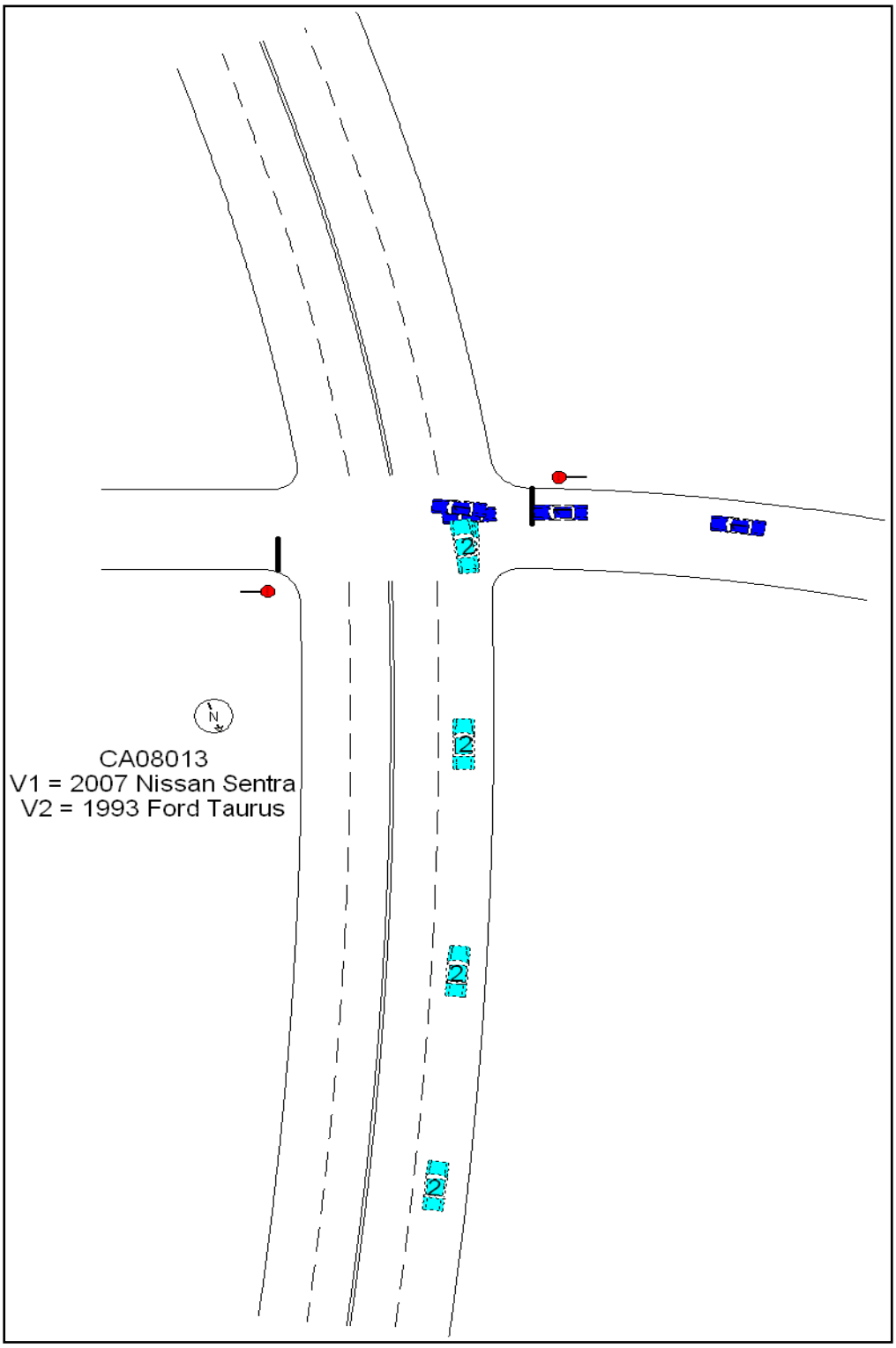

Figure 9: Scene Schematic