

**TRANSPORTATION SCIENCES  
CRASH RESEARCH SECTION**

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**CALSPAN REMOTE DRIVER AIR BAG FATALITY INVESTIGATION  
CALSPAN CASE NO. CA97-22  
VEHICLE: 1991 CHEVROLET CAPRICE  
LOCATION: FLORIDA  
CRASH DATE: JUNE, 1991**

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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. <i>Abstract</i> <p>This remote investigation focused on the injury mechanisms of a fatally injured driver of a 1991 Chevrolet Caprice that was involved in a front-to-rear crash with a 1984 Nissan Sentra and a subsequent front center impact with a utility pole. The Caprice was equipped with a driver air bag system that deployed as a result of the pole impact. The driver was out-of-position in a forward direction against the steering wheel and the air bag module assembly at impact. The air bag deployed against her chest which resulted in bilateral rib fractures and multiple internal injuries which included a laceration of the aorta. Due to her forward position, the driver restricted the deployment path of the air bag. The upper third of the bag membrane subsequently expanded through the top of the module cover as the cover separated from the module assembly. The driver was removed from the vehicle and transported by helicopter to a regional trauma center where she expired approximately 8.5 hours following the crash.</p> <p>This crash was identified by NHTSA in June, 1997, and assigned as a remote investigative effort. The investigating police department was consolidated into the local Sheriff's Department in October, 1995. All police photographs were destroyed following the consolidation. Three remaining photographs of the Caprice's damage patterns and deployed air bag were obtained from the insurance company. In addition, the police crash report and medical records (hospital and autopsy) were obtained from various sources which provided the data for this report.</p>			
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***Background***

This remote air bag deployment investigation focused on a driver fatality of an air bag equipped 1991 Chevrolet Caprice. The Caprice initially impacted the back right area of a 1984 Nissan Sentra station wagon. The vehicle subsequently impacted a wooden utility pole with the center frontal area which deployed the driver air bag system (**Figure 1**). The 36 year old female driver of the Caprice was out of position forward against the air bag module and steering assembly at impact. She sustained thoracic and abdominal injuries which included multiple left ribs fractures with hemothorax, a laceration of the aorta, and multiple injuries of the colon, small bowel, mesentery, and pancreas. The thoracic injuries were attributed to air bag deployment while the lower abdominal injuries resulted from bag expansion and driver loading against the steering wheel rim. She was airlifted to a major trauma center where she expired approximately 8.5 hours following the crash.



**Figure 1. Altered deployment of the driver air bag and separated module cover.**

This case was initially identified by General Motors as a result of a NHTSA request to the motor vehicle manufacturers for information regarding air bag related injuries and fatalities. The crash occurred in Florida, in June, 1991, and was assigned to Calspan's Special Crash Investigation team on June 4, 1997. The local police department that investigated the crash was consolidated into the County Sheriff's Department on October 1, 1995. The County Sheriff's Department gained possession of all public records and documents that pertained to the investigating police department. Both the Sheriff's Department and the local City Hall were contacted in an attempt to obtain photographs of the crash. Both agencies noted that the photographs were destroyed during the consolidation, therefore none were available from the police. The officer in-charge of property and evidence for the Sheriff's Department stated that he remembered the crash, but was not involved in the investigation. Three photographs and the medical records were obtained through the driver's insurance carrier. This summary is based on the detailed police crash reports, the hospital and autopsy records, and the photographic documentation of the vehicle.

***SUMMARY***

***Crash Site***

The crash occurred on a six lane divided state route during daylight (evening) hours. The conditions were police reported as overcast and dry. The asphalt roadway was configured with two through lanes in both the east and westbound direction of travel and two designated left turn lanes for westbound traffic flow. The east and westbound lanes were separated by a raised median. The posted speed limit was 64 km/h (40 mph).

### ***Pre-Crash***

The 69 year old male driver of a 1984 Nissan Sentra station wagon initiated a right turn onto the state route and accelerated in a westerly direction. He checked for approaching traffic in his rear view mirrors and initiated a lane change maneuver onto the inboard travel lane. He estimated his travel speed at approximately 40 km/h (25 mph). The driver of the Caprice had departed a social event and was en route to her residence. She was traveling in a westerly direction on the inboard through lane of the divided state route on an approach to a signalized intersection. Her speed was unknown, however, she was traveling at a velocity that was greater than the Nissan as she approached the rear of the slower moving vehicle.

The driver of the Caprice was highly intoxicated with a BAC of .299. As she approached the Nissan, the driver of the Caprice braked and steered to the right in an attempt to avoid impact. The investigating officer documented a clockwise arcing left front tire mark that was 5.2 m (17.0') in length that terminated at the impact with the Nissan.



**Figure 2. Frontal view of the pole impact damage.**

### ***Crash***

The front left area of the 1991 Caprice (**Figure 2**) impacted the back right corner area of the 1984 Nissan Sentra resulting in a probable 12/6 o'clock impact configuration. The impact redirected the Nissan to its left as it traversed the two left turn lanes, the median, and the eastbound travel lanes before coming to a controlled stop in a parking lot adjacent to the east curbline. Based on the insurance company photographs, the Caprice sustained moderate damage, however, the severity of the crash did not warrant deployment of the driver air bag system.

The Caprice was redirected to its right as it crossed the outboard travel lane, mounted a barrier curb, traversed a concrete sidewalk and impacted a utility pole with the front center area of the vehicle (**Figure 2**). The pole impact crushed the front center bumper to an estimated depth of 35-40 cm (14-16"). As a result of the impact, the Caprice underwent a longitudinal velocity change of 24-29 km/h (15-18 mph) which deployed the driver air bag system. The Caprice came to rest engaged against the struck pole. The driver of the Caprice was found slumped across the front seat with her head adjacent to the right front door. The investigating police officer noted in his report that the driver was not restrained by the manual 3-point lap and shoulder belt system and that the driver's side air bag had deployed. He further noted that the steering wheel was damaged from driver contact.

The driver was transported by helicopter to a local trauma hospital where she expired approximately 8.5 hours following the crash. The medical examiner identified the cause of death as multiple blunt force injuries of the trunk which were associated with air bag and steering wheel loading.

## ***VEHICLE DATA***

The involved 1991 Chevrolet Caprice was identified by vehicle identification number (VIN) 1G1BN53E6MW (production number deleted). The police report noted an odometer reading of (700.7 miles). The vehicle was a four-door sedan with manual 3-point lap and shoulder belts located at the four outboard seated positions. The Caprice was equipped with a SIR system that consisted of a frontal air bag for the driver's position which deployed during the crash sequence.

## ***VEHICLE DAMAGE***

### ***1991 Chevrolet Caprice Exterior***

The Chevrolet Caprice was not inspected for this remote investigation. The damage profiles were documented photographically by the insurance carrier for the driver. These photographs were provided to the SCI team. Police photographs were destroyed following the consolidation of the department.

The Caprice sustained moderate damage from its initial impact with the Nissan Sentra. Direct contact damage occurred to the front bumper fascia directly outboard of the left headlamp assembly and to the leading edge of the right front fender and left hood edge. The crush, if any, at bumper level had been masked by the subsequent front center impact with the utility pole. Based on the damage to the front left corner area of the vehicle, it was doubtful that this impact would have deployed the driver air bag system. The Collision Deformation Classification (CDC) for this impact was 12-FLEE-1.

The second crash event involved a front center impact sequence with a wooden utility pole. The investigating officer noted in his report that the pole was not fractured, however, the pole was displaced and was leaning at a 15-20 degree angle. The direct damage to the vehicle occurred at the centerline and involved the front bumper, grille, radiator support panel, and the hood. Maximum crush was estimated at 35-40 cm (14-16") with a total velocity change of 24-29 kph (15-18 mph). The 12 o'clock direction of force impact was sufficient to deploy the Caprice's supplemental driver air bag system. The CDC for this impact was 12-FCEN-2 (**Figure 3**).



**Figure 3. Center frontal pole damage.**

### ***Interior***

Vehicle interior damage was limited to deployment of the SIR and driver loading of the steering assembly and the instrument panel. At deployment, the driver was positioned against the driver air bag module cover assembly which restricted the deployment path of the air bag. The air bag membrane initially deployed from the H-configuration module cover flaps, however, as the bag continued to inflate against the driver, the bag was redirected and expanded between the module cover and the steering wheel assembly, separating the module cover from the module assembly. Therefore, the bag was restricted by the module cover and was not able to inflate in a typical round configuration.

The driver loaded the steering wheel as she responded to the 12 o'clock impact force. Her loading of the wheel compressed the wheel in a forward direction apparently deforming the wheel rim and spokes. Although not documented by the officers or visible in the interior photograph, the energy absorbing steering column was probably compressed due to driver loading of the wheel and the subsequent expansion of the bag against the forward positioned driver.

The investigating officers noted in their post-crash inspection of the vehicle that the instrument panel was damaged due to driver contact. This damage was not visible in the interior photograph. It was possible that the damage occurred to the knee bolster of the Caprice, indicating the driver possibly submarined the steering assembly as she initiated her forward trajectory.

***DRIVER DEMOGRAPHICS/DATA***

Driver: 36 year old female  
 Height: 167.6 cm (66.0")  
 Weight: 73 kg (160 lb)  
 Manual Restraint  
 Usage: None, 3-point lap and shoulder belt was available  
 Usage Source: Officer's observation at scene of crash  
 BAC: .299 mg/dl  
 Eyeware: Unknown  
 Trip Plan: Returning to residence  
 Vehicle Familiarity: Unknown  
 Route Familiarity: Unknown  
 Mode of Transport  
 From Scene: Helicopter transport  
 Type of Medical  
 Treatment: Admitted to a trauma center where she expired approximately 8.5 hours following the crash.

***DRIVER INJURIES***

<b>Injury</b>	<b>Injury Severity (AIS 90)</b>	<b>Injury Mechanism</b>
<u>Autopsy</u> Partial laceration of the left posterior side of the aorta, 8 cm (3") below the origin of the left brachiocephalic artery associated with 1000 cc of retroperitoneal hemorrhage	Critical (420212.5,4)	Deploying driver air bag and module cover flaps



Fractures of the left lateral 3rd-7th ribs and fractures of the left 3rd-5th at the costosternal junction with bilateral hemothorax (left 850 cc and right 200 cc)	Severe (450232.4,2)	Deploying driver air bag and module cover flaps
Numerous intramural small bowel hematomas	Moderate (541410.2,8)	Deploying driver air bag and module cover flaps in combination with loading of the lower steering wheel rim
Scattered mesenteric hematomas with 200 cc of blood	Moderate (542010.2,8)	Deploying driver air bag and module cover flaps in combination with loading of the lower steering wheel rim
Left intra-ovarian 40 cc hematoma	Moderate (542610.2,2)	Deploying driver air bag and module cover flaps in combination with loading of the lower steering wheel rim
100 cc hemorrhage in the body of the pancreas (NFS)	Moderate (542810.2,7)	Deploying driver air bag and module cover flaps
Superficial hematomas on the anterior surface of the liver	Moderate (541812.2,1)	Deploying driver air bag and module cover flaps
Presternal hematoma with 200 cc of blood	Minor (450802.1,4)	Deploying driver air bag and module cover flaps
Subcapsular hematoma over the frontal bone	Minor (190402.1,5)	Probable contact with the upper steering wheel rim
Subcapsular hematoma over the occipital bone	Minor (190402.1,6)	Probable rebound contact into the left upper B-pillar
Hematoma in the posterior and superior mediastinum	N/A, not codeable under AIS 90 rules	Deploying driver air bag and module cover flaps

<u>Hospital Medical Records</u> Tear of the left crura of the diaphragm	Serious (440604.3,8)	Deploying driver air bag and module cover flaps
Splenic rupture	Severe (544224.3,2)	Deploying driver air bag and module cover flaps
Avulsion of the mesenteric transverse colon	Severe (440826.4,8)	Deploying driver air bag and module cover flaps
Tear of the left colon mesentery	Moderate (542020.2,8)	Deploying driver air bag and module cover flaps
Tear of the mesenteric vessels, splenic flexure colon, and the splenic vessels	Serious (521402.3,9)	Deploying driver air bag and module cover flaps
Ecchymosis over the left breast	Minor (490402.1,2)	Deploying driver air bag and module cover flaps

### ***DRIVER KINEMATICS***

The driver the 1991 Chevrolet Caprice was probably seated in an upright driving position with the seat track adjusted to a forward or mid track position at the initial impact with the Nissan Sentra. She was not restrained by the manual belt system. The lack of belt usage was determined by the initial observations of the first responders to the crash scene. The driver was found slumped across the front seat in an unconscious state with her head resting on the seat cushion near the right front door.

The driver applied a clockwise steering input and braked in an attempt to avoid impact with the Nissan. The initial impact with the Nissan Sentra resulted in minor damage to the front left corner area of the Caprice. The resultant damage and the crash circumstances (minor front-to-rear impact sequence with a slower moving vehicle) did not warrant deployment of the driver air bag system. She was probably displaced in a forward direction as she responded to the 12 o'clock impact force.

The Caprice departed the right road edge and traversed a rain gutter, a curb, and a sidewalk prior to the center frontal impact with the pole. During this trajectory and as a result of the vehicle overriding the curb, the driver slumped forward against the steering wheel and driver air bag module. At impact with the pole, the driver air bag system deployed as the driver responded to the 12 o'clock force.

Due to the driver's forward position against the air bag module assembly at deployment, she impeded the opening of the H-configuration module cover flaps and the subsequent expansion of the air bag membrane. As a result, the expanding air bag membrane partially deployed from the module cover flaps, however, was restricted by the driver's torso. The continued expansion of the bag membrane within the module separated the module cover from the module mounting bracket (**Figure 4**). The upper portion of the air bag subsequently expanded through the top of the module assembly, between the cover and the steering wheel. The upper center area of the air bag membrane was restricted by the vinyl module cover, therefore the bag could not fully inflate in a typical round configuration.



**Figure 4. Separated module cover and restricted air bag.**

The driver's loading of the air bag and steering wheel rim resulted in forward bending of the steering wheel rim and spokes as evidenced by the photograph provided by the insurance carrier. In addition, the investigating officer noted steering wheel damage due to driver loading during the post-crash inspection of the vehicle.

The expansion of the air bag module cover flaps and air bag membrane against the driver's torso resulted in ecchymosis over the left breast, multiple rib fractures, a partial laceration of the left posterior aorta, superficial hematomas of the anterior liver, tear of the diaphragm, splenic rupture, an avulsion of the mesenteric transverse colon, tear of the left colon mesentery, and a tear of the mesenteric vessels, splenic flexure colon, and the splenic vessels.

The driver's lower abdominal area loaded the lower steering wheel rim as the air bag deployed against the forward positioned driver as she responded to the 12 o'clock impact force. The combination of air bag and steering wheel loading resulted in numerous intramural small bowel hematomas, scattered mesenteric hematomas, and a left intra-ovarian hematoma. She probably partially submarined the steering assembly which allowed her frontal scalp to impact the upper steering wheel rim resulting in a subcapsular hematoma over the frontal bone. The driver sustained a subscapular hematoma over the occipital bone which probably resulted from rebound contact against the upper left B-pillar.

The driver reportedly (police report) slumped to her right and came to rest lying on the front seat cushion with her head resting near the right front door panel. She was found in an unconscious state with the manual belt system retracted against the B-pillar.

### ***MEDICAL TREATMENT***

The driver was treated at the scene of the crash by the flight crew medical staff. She regained consciousness and was conversant with the crew. She was able to provide the crew with her husband's name and her home phone number. The driver was subsequently transported from the scene by helicopter to a regional trauma center where she was admitted for treatment.

On arrival, her Glasgow Coma Score (GCS) was 13 and her blood pressure was recorded at 70. Arterial blood gases identified her hgb at 7 and she was immediately transfused with 2 units of packed cells. The driver was taken to the operating room within 15 minutes of her arrival to the hospital for repair of the abdominal bleeding. In the OR, she received 12 units of blood, 20 units of platelets, 4 units of packed cells, and 10 units of cryoprecipitate. Her condition deteriorated and she expired approximately 8.5 hours following the crash.