**TRANSPORTATION SCIENCES**
**CRASH DATA RESEARCH CENTER**

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# REMOTE AIR BAG RELATED CHILD PASSENGER FATALITY INVESTIGATION
# SCI TECHNICAL SUMMARY REPORT

**VERIDIAN CASE NO. CA00-055**

**VEHICLE - 1997 CHEVROLET CAVALIER**

**LOCATION - STATE OF WEST VIRGINIA**

**CRASH DATE - DECEMBER 1999**

Contract No. DTNH22-94-D-07058

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

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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*<br>This investigation focused on a two vehicle crash that involved a 1997 Chevrolet Cavalier (subject vehicle) and a 1994 Chevrolet Blazer. The Cavalier was equipped with frontal air bags that deployed as a result of an intersection collision with the Chevrolet Blazer. The Cavalier was occupied by a 32-year-old female driver, 14-year-old female front right passenger, a 10-year-old male seated on the lap of the front right passenger and a 12-year-old female rear left passenger. None of the occupants were restrained by the manual 3-point lap and shoulder belt systems. The Chevrolet Cavalier was traveling southbound in the outboard lane of a 4-lane divided highway on approach to a 4-leg intersection. The driver of the Chevrolet Blazer initiated a left turn across the path of the Cavalier. As the Cavalier entered intersection, the front area of the Cavalier impacted the left side of the Blazer. Impact resulted in moderate damage to both vehicles. At impact, the frontal air bags deployed. The 32-year-old female driver of the Cavalier was unrestrained and contacted the deployed driver's air bag. She sustained no visible injuries. The 10-year-old male passenger seated on the lap of the front right passenger was positioned in the path of the front right passenger's air bag and initiated a forward trajectory. The air bag expanded against his neck and chest and redirected him rearward. He sustained an interventricular hemorrhage, a C1 fracture with displacement of the occipital bone, a transection of the spinal cord, facial abrasions, facial contusions, neck abrasions, and neck contusions. He rebounded rearward and struck the front right occupant, which resulted in an acute subacrachnoid hemorrhage. He was transported by ambulance to a local hospital where he expired 23 hours following the crash. The remaining two child occupants of the Cavalier sustained police-reported visible injuries and were transported by ambulance to a local hospital. The driver of the 1994 Chevrolet Blazer sustained police-reported visible injuries and was transported by ambulance to a local hospital. | | | |
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**REMOTE AIR BAG RELATED CHILD PASSENGER FATALITY INVESTIGATION**
**SCI TECHNICAL SUMMARY REPORT**
**VERIDIAN CASE NO. CA00-055**
**VEHICLE - 1997 CHEVROLET CAVALIER**
**LOCATION: STATE OF WEST VIRGINIA**
**CRASH DATE - DECEMBER 1999**

## *BACKGROUND*

This investigation focused on a two vehicle crash that involved a 1997 Chevrolet Cavalier (subject vehicle) and a 1994 Chevrolet Blazer. The Cavalier was equipped with frontal air bags that deployed as a result of an intersection collision with the Chevrolet Blazer. The Cavalier was occupied by a 32-year-old female driver, 14-year-old female front right passenger, a 10-year-old male seated on the lap of the front right passenger and a 12-year-old female rear left passenger. None of the occupants were restrained by the manual 3-point lap and shoulder belt systems. The Chevrolet Cavalier was traveling southbound in the outboard lane of a 4-lane divided highway on approach to a 4-leg intersection. The driver of the Chevrolet Blazer initiated a left turn across the path of the Cavalier. As the Cavalier entered intersection, the front area of the Cavalier impacted the left side of the Blazer. Impact resulted in moderate damage to both vehicles. At impact, the frontal air bags deployed. The 32-year-old female driver of the Cavalier was unrestrained and contacted the deployed driver's air bag. She sustained no visible injuries. The 10-year-old male passenger seated on the lap of the front right passenger was positioned in the path of the front right passenger's air bag and initiated a forward trajectory. The air bag expanded against his neck and chest and redirected him rearward. He sustained an interventricular hemorrhage, a C1 fracture with displacement of the occipital bone, a transection of the spinal cord, facial abrasions, facial contusions, neck abrasions, and neck contusions. He rebounded rearward and struck the front right occupant, which resulted in an acute subacrachnoid hemorrhage. He was transported by ambulance to a local hospital where he expired 23 hours following the crash. The remaining two child occupants of the Cavalier sustained police-reported visible injuries and were transported by ambulance to a local hospital. The driver of the 1994 Chevrolet Blazer sustained police-reported visible injuries and was transported by ambulance to a local hospital.

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for child fatalities that occurred in vehicles equipped with air bags. The crash occurred in December 1999 and was assigned to the Veridian Special Crash Investigation Team on November 3, 2000 as a remote investigation effort. Police photographs and an autopsy report were obtained, which provided the basis for this narrative report.

## *SUMMARY*

### Crash Site

This two vehicle crash occurred during the daylight hours of December 1999. At the time of the crash, there were no adverse conditions as the asphalt road surface was dry. The crash occurred at the 4-leg intersection of a 4-lane, north/south, divided state roadway and a two-lane, east/west state roadway. The two southbound travel lanes were bordered on the right by a right-turn lane for southbound traffic turning

west. The eastbound lane of the 2-lane roadway also widened to accommodate a right-turn lane for traffic turning south. Both turn lanes were separated from the travel lanes by painted white lines. Eastbound traffic control consisted of a two single flashing red traffic signals and a stop sign. Traffic control for the southbound traffic consisted of two single flashing amber signals. Both roadway surfaces were straight with a level grade. The posted speed limit was 88 km/h (55mph) for the north/south roadway and 72km/h (45 mph) for the east/west roadway.

**Pre-Crash**

The 32-year-old female driver of the Chevrolet Cavalier was operating the vehicle southbound in the outboard travel lane on approach to the 4-leg intersection. According to the statement from the driver of the Cavalier, the Blazer had stopped prior to entering the intersection, and initiated a left turn across the path of the Cavalier as the Cavalier entered the intersection. There were no skid marks within the Cavalier's trajectory indicative of any avoidance maneuvers.

The driver of the Chevrolet Blazer stated that the Blazer was stopped at the intersection waiting to turn left. She stated that she saw the southbound Cavalier approaching, but thought it was traveling in the right turn lane. She stated that she misjudged the proximity of the Cavalier to the intersection as she initiated the left turn.

**Crash**

As the Cavalier entered the intersection, the front area of the Cavalier impacted the left center area of the Chevrolet Blazer. Impact resulted in moderate damage to both vehicles. The principal direction of force was in the 1 o'clock sector for the Cavalier and in the 10 o'clock sector for the Blazer. The damage algorithm of the WinSMASH program computed velocity changes of 17.0 km/h (10.6 mph) for the Cavalier. The longitudinal and lateral components were -16.0 km/h (-9.9 mph) and -5.8 km/h (-3.6 mph), respectively. Impact induced deceleration was sufficient to deploy the frontal air bag system in the Cavalier. The damage algorithm of the WinSMASH program computed velocity changes of 13.0 km/h (8.1 mph) for the Blazer. The longitudinal and lateral components were -6.5 km/h (-4.0 mph) and 11.3 km/h (7.0 mph), respectively. The front left area of the Cavalier under rode the left side of the Blazer forward of the left rear wheel. This caused both vehicles to rotate in a counterclockwise (CCW) direction approximately 30 degrees before disengagement. The Cavalier rotated CCW approximately 90 degrees from impact to final rest, and the Blazer rotated CCW approximately 170 degrees from impact to final rest **(Figure 1)**.

**Figure 1. Crash site showing the final rest positions of both vehicles**

**Post-Crash**

Reports did not indicate how the occupants of the 1997 Chevrolet Cavalier exited the vehicle. The 32-year-old female driver of the Cavalier was reportedly not injured, but transported by ambulance to a local hospital. Her admission status was not reported. According to the police report, the front right occupant

and rear left occupant were transported by ambulance to a local hospital for treatment. Their admission status was not reported. The 10-year-old male passenger seated on the lap of the front right passenger was transported by ambulance to a local hospital and admitted. He expired 23 hours following the crash.

The driver of the 1994 Chevrolet Blazer was removed from the vehicle by rescue personnel. She was transported by ambulance to a local medical center for treatment. Her admission status was not reported.

***SUBJECT VEHICLE - 1997 Chevrolet Cavalier***

The 1997 Chevrolet Cavalier was identified by the Vehicle Identification Number (VIN) 1G1JC5242V7 (production sequence omitted). The vehicle was a 4-door sedan equipped with front wheel drive and a 2.2 liter, 4-cylinder engine. The seating was configured with front bucket seats and a rear bench seat. The police report listed the driver as the owner of the vehicle. Plastic trash bags possibly filled with clothing were noted in the rear right and rear center positions.

***VEHICLE DAMAGE***

**Exterior Damage - *1997 Chevrolet Cavalier***

The 1997 Chevrolet Cavalier sustained moderate damage as a result of the impact with the Chevrolet Blazer. The Collision Deformation Classification (CDC) for the frontal impact to the Cavalier was 01-FYEW-2. The direct and induced damage involved the entire frontal width of the Cavalier **(Figure 2)**. Direct contact damage along the front of the Cavalier began approximately 15 cm (6") to the right of the centerline and extended laterally to the left bumper corner. The bumper fascia was cracked on the lower aspect approximately 15cm (6") to the left of the centerline and had contact damage on the top aspect from the under ride to the Blazer. The left bumper corner was displaced rearward and downward. The left fender was displaced rearward and buckled toward the center of the Cavalier **(Figure 3)**. The hood was buckled at the designated fold points. The direct and induced damage involved the entire frontal width of the Cavalier. Six crush measurements were estimated at the level of the bumper from the on-scene photographs: C1 = 40 cm (16"), C2 = 35 cm (14"), C3 = 25 cm (10"), C4 = 10 cm (4"), C5 = 5 cm (2"), C6 = 0 cm.

**Figure 2. Frontal damage to the Cavalier**

**Figure 3. Damage to the left bumper corner and left fender**

**Interior Damage - *1997 Chevrolet Cavalier***

Interior damage to the 1997 Chevrolet Cavalier was based on exterior police photos, and appeared to be minimal **(Figure 4)**. The windshield was cracked on the right side, but it was unknown if it was due to occupant contact.

**Figure 4. Interior view through the left front door**

**Exterior Damage - *1994 Chevrolet Blazer***

The 1994 Chevrolet Blazer sustained moderate left side damage as a result of the impact with the Chevrolet Cavalier. The Collision Deformation Classification (CDC) was 10-LPEW-2. Direct contact damage began on the lower aspect of the left rear door, approximately 38 cm (15") aft of the B-pillar and extended approximately 30 cm (12") rearward to the left rear wheel. The direct damage extended vertically from the bottom edge of the left rear door approximately 45 cm (18"). The direct and induced damage involved the entire lower half of the left rear door **(Figure 5)**. The left rear wheel was rotated counterclockwise (CCW) approximately 10 degrees, and the rear axle displaced rearward on the left side. Six crush measurements were estimated at the trim level on the left rear door: C1 = 0 cm, C2 = 4 cm(2"), C3 =15 cm (6"), C4 = 10 cm (4"), C5 = 5 cm(2"), C6 = 0 cm.

**Figure 5. Exterior damage to the Blazer**

***FRONTAL AIR BAG SYSTEM - 1997 Chevrolet Cavalier***

The 1997 Chevrolet Cavalier was equipped with frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the impact with the 1994 Chevrolet Blazer. The driver's air bag was housed in the center of the steering wheel with symmetrical I-configuration module cover flaps.

The front right passenger's air bag deployed from the right upper instrument panel area with a single cover flap design. The cover flap was rectangular in shape and hinged at the top aspect. In the on-scene photographs, a stuffed animal was wedged between the outer aspect of the cover flap and the windshield.

## *OCCUPANT DEMOGRAPHICS - 1997 Chevrolet Cavalier*

### Driver

| | |
|---|---|
| Age/Sex: | 32-year-old female |
| Height: | Not reported |
| Weight: | Not reported |
| Seat Track Position: | Mid-track (from on-scene photos) |
| Manual Restraint Use: | Unrestrained |
| Usage Source: | Police report |
| Eyewear: | Not reported |
| Type of Medical Treatment: | Reportedly not injured, but transported by ambulance to local hospital for evaluation |

### Driver Kinematics

The 32-year-old female driver of the 1997 Chevrolet Cavalier was seated in a presumed upright posture at the time of the crash. She was not restrained by the available 3-point lap and shoulder belt system and initiated a forward trajectory in response to the 1 o'clock impact force. She loaded the driver's air bag which provided additional protection from the frontal crash forces. She was reportedly not injured, however was transported by ambulance to a local hospital for evaluation. Her admission status was not reported.

### Front Right Passenger (In Lap)

| | |
|---|---|
| Age/Sex: | 10-year-old male |
| Height: | 137cm (54") |
| Weight: | 35 kg (77 lb) |
| Seat Track Position: | Between mid-track and full-rear (from on-scene photos) |
| Manual Restraint Use: | Unrestrained |
| Usage Source: | Police report, injuries |
| Eyewear: | Not reported |
| Type of Medical Treatment: | Transported by ambulance to a local hospital and expired 23 hours following the crash |

**Front Right Passenger (In Lap) Injuries**

| Injury | Injury Severity (AIS 90/Update 98) | Injury Mechanisms |
|---|---|---|
| Fracture of C-1 with displacement from occipital bone with transection injury to spinal cord | Maximum (640276.6,6) | Front right passenger's air bag |
| Interventricular hemorrhage | Severe (140678.4,9) | Front right passenger's air bag |
| Subarachnoid hemorrhage | Serious (140684.3,9) | Occupant-to-occupant contact with front right passenger |
| 3 x 3 cm abrasion -right forehead | Minor (290202.1,1) | Front right passenger's air bag |
| 3 x 3 cm contusion - right forehead | Minor (290402.1,1) | Front right passenger's air bag |
| Diffuse abrasions - anterolateral aspect of neck | Minor (390202.1,5) | Front right passenger's air bag |
| Diffuse contusions- anterolateral aspect of neck | Minor (390402.1,5) | Front right passenger's air bag |
| Abrasions - right lower chin | Minor (290202.1,8) | Front right passenger's air bag |
| Contusions - right lower chin | Minor (290402.1,8) | Front right passenger's air bag |
| 1 cm abrasion -right anterior lower leg | Minor (890202.1,1) | Front right passenger's air bag |

Injury source: Medical Examiner's Postmortem Report

**Front Right Passenger (In Lap) Kinematics**

The 10-year-old male occupant was presumed to be seated in an upright posture on the lap of the 14-year-old female front right passenger, which caused him to be slightly out-of-position forward. He was not restrained by the available 3-point lap and shoulder belt system. At impact with the Chevrolet Blazer, the slight under ride of the Cavalier probably caused the 10-year-old male occupant to travel further forward before the frontal air bag system deployed. As the vehicles engaged, the frontal air bag system deployed. He continued the forward trajectory in response to the 1 o'clock impact force into the path of the expanding front right passenger's air bag. The air bag expanded against his neck and upper chest. He sustained an interventricular hemorrhage, a C1 fracture with displacement of the occipital bone, a transection of the spinal cord, facial abrasions, facial contusions, neck abrasions, and neck contusions. The

child was redirected rearward by the air bag and struck the rear aspect of his head on the 14-year-old front right passenger's head, which resulted in an acute subacrachnoid hemorrhage. He was transported by ambulance to a local hospital and expired 23 hours following the crash.

**Front Right Passenger and Rear Left Passenger Kinematics**

The 14-year-old female front right passenger was seated in a presumed upright posture. She was not restrained by the 3-point lap and shoulder belt. The unrestrained 10-year-old male passenger was seated on her lap at the time of the crash. At impact, she initiated a forward trajectory in response to the frontal impact force. She probably traveled forward with the 10-year-old and loaded against him as he loaded the expanding air bag. She may have been struck by the 10-year-old as he rebounded rearward. According to the police report, her injury classification was coded as, "bleeding wound, distorted member, or had to be carried from scene." She was transported by ambulance to a local hospital. Her admission status was not reported.

The 12-year-old female rear left passenger was presumed to be seated in an upright posture. She was not restrained by the available 3-point lap and shoulder belt system. At impact with the Blazer, she initiated a forward trajectory in response to the frontal impact force, and probably loaded the driver's seat back. According to the police report, her injury classification was coded as, "bleeding wound, distorted member, or had to be carried from scene." She was transported by ambulance to a local hospital. Her admission status was not reported.