TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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REMOTE REDESIGNED AIR BAG RELATED CHILD FATALITY INVESTIGATION SCI TECHNICAL SUMMARY REPORT

VERIDIAN CASE NO. CA99-051

RABSS VEHICLE - 1998 CHEVROLET CAVALIER

LOCATION - STATE OF TENNESSEE

CRASH DATE - NOVEMBER 1998

Contract No. DTNH22-94-D-07058

Prepared for:

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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 remote investigation focused on a two vehicle crash that involved a 1998 Chevrolet Cavalier (subject vehicle) and a 1989 Buick LeSabre. The Chevrolet Cavalier was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with the Buick LeSabre. The driver of the Cavalier was operating the vehicle westbound on approach to a 3-leg (T) intersection when the driver of the LeSabre attempted to turn left across the path of the Cavalier. The front left area of the Cavalier impacted the right front side area of the LeSabre. Impact resulted in moderate damage to both vehicles. The Cavalier was occupied by a 26-year-old female driver and eight additional passengers ranging in age from 9 months to 18 years. The 2-year-old male was seated on the lap of the 18-year-old female in the front right position. All remaining occupants were positioned in the rear seat area. The 26-year-old female driver of the Cavalier was unrestrained and sustained non-incapacitating injuries. The 2-year-old passenger seated on the lap of the front right passenger initiated a forward trajectory due to pre-impact braking. At impact the deploying front right air bag cover flap and/or air bag membrane contacted the underside of his chin, resulting in atlanto-occipital dislocation and a brain stem injury. He was transported by ambulance to the emergency room (ER) of a regional trauma center where he expired two days later. All other occupants of the Cavalier sustained police reported "C" level injuries and were transported by ambulance to the ER of a regional trauma center and later released. The 59-year-old driver of the Buick LeSabre sustained a possible injury, and was transported by ambulance to an ER of a regional trauma center and later released.

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BACKGROUND

Figure 1. On-scene photograph

This remote investigation focused on a two vehicle crash that involved a 1998 Chevrolet Cavalier (subject vehicle) and a 1989 Buick LeSabre **(Figure 1)**. The Chevrolet Cavalier was equipped with redesigned frontal air bags that deployed as a result of a frontal collision with the Buick LeSabre. The driver of the Cavalier was operating the vehicle westbound on approach to a 3-leg (T) intersection when the driver of the LeSabre attempted to turn left across the path of the Cavalier. The front left area of the Cavalier impacted the right front side area of the LeSabre. Impact resulted in moderate damage to both vehicles. The Cavalier was occupied by a 26-year-old female driver and eight additional passengers ranging in age from 9 months to 18 years. The 2-year-old male was seated on the lap of the 18-year-old female in the front right position. All remaining occupants were positioned in the rear seat area. The 26-year-old female driver of the Cavalier was unrestrained and sustained non-incapacitating injuries. The 2-year-old passenger seated on the lap of the front right passenger initiated a forward trajectory due to pre-impact braking. At impact the deploying front right air bag cover flap and/or air bag membrane contacted the underside of his chin, resulting in atlanto-occipital dislocation and a brain stem injury. He was transported by ambulance to the emergency room (ER) of a regional trauma center where he expired two days later. All other occupants of the Cavalier sustained police reported "C" level injuries and were transported by ambulance to the ER of a regional trauma center and later released. The 59-year-old driver of the Buick LeSabre sustained a possible injury, and was transported by ambulance to an ER of a regional trauma center and later released.

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for fatalities that occurred in vehicles equipped with redesigned air bags. The crash occurred in November 1998 and was assigned to the Veridian Special Crash Investigation Team on September 2, 1999 as a remote investigation effort. Police photographs and a death certificate were obtained, which provided the basis for this narrative report.

SUMMARY

Crash Site

This two vehicle crash occurred during the nighttime hours of November 1998. At the time of the crash, it was dark and foggy. The asphalt road surfaces were wet, and the street lights along the side of the roadway were illuminated. The crash occurred at an urban 3-leg (T) intersection of two municipal

roadways. The west side of the east/west roadway consisted of two travel lanes that were straight with a slight positive grade to the west. The eastbound lane widened to encompass an additional left turn lane for eastbound traffic to turn north. The east side of the east/west roadway consisted of two travel lanes separated by a center turning lane. There was also a right turn lane for westbound traffic to turn north, separated by painted lines and a concrete island in the intersection. Additionally, an at-grade railroad crossing intersected the roadway at an estimated angle of 85 degrees. Traffic controls consisted of railroad cross bucks with flashers at the grade crossing and a "no passing zone" sign on the east side of the intersection facing westbound traffic. The north/south roadway consisted of two travel lanes that were straight with a level grade. A right turn lane branched from the southbound lane at the intersection separated by a small triangular concrete island. Traffic control consisted of a stop sign for southbound traffic turning left into the eastbound lane, and a yield sign for southbound traffic turning right into the westbound lane. The posted speed limit for the east/west roadway was 64 km/h (40 mph).

Pre-Crash

The 26-year-old female driver of the Chevrolet Cavalier was operating the vehicle westbound on approach to the urban 3-leg (T) intersection when she detected the Buick LeSabre attempting to turn left (north)across the path of the Cavalier. Upon recognition of the impending harmful event, the driver of the Cavalier applied the brakes in an attempted avoidance maneuver resulting in police reported 5.3 meters (17.5') of longitudinal pre-impact skid marks.

The 59-year-old female driver of the Buick LeSabre was operating the vehicle eastbound on approach to the 3-leg intersection. She failed to detect the approaching Chevrolet Cavalier traveling westbound and initiated a left turn across the path of the Cavalier. There were no skid marks within the vehicle's trajectory to indicate any avoidance maneuver.

Crash

As the Chevrolet Cavalier entered the intersection, the front left area impacted the right front side area of the Buick LeSabre. Impact resulted in moderate damage to both vehicles. The impact induced deceleration was sufficient to deploy the frontal air bag system in the Cavalier. The principal direction of force for this impact to the Cavalier was in the 11 o'clock sector. The damage algorithm of the WinSMASH program computed velocity changes of 22 km/h (14 mph) for the Cavalier based on the estimated CDC value. The principal direction of force for this impact to the LeSabre was in the 2 o'clock sector. The damage algorithm of the WinSMASH program computed velocity changes of 21 km/h (13 mph) for the LeSabre based on the estimated CDC value. The Cavalier rotated approximately 20 degrees counterclockwise (CCW), traveled in a west direction, and came to rest in the intersection facing west. The LeSabre rotated approximately 50 degrees CCW, and came to rest in the intersection facing north **(Figure 2)**.

Figure 2. Point of impact and final rest positions

Post-Crash

It was unknown as to how any of the occupants exited the vehicles. The 2-year-old male seated on the right front passenger's lap of the Cavalier was transported to a regional children's hospital and expired two days following the crash. The front right passenger of the Cavalier was transported by ambulance to the emergency room of a regional trauma center for treatment of police reported non-incapacitating visible injuries and later released. The seven remaining occupants of the Cavalier were transported by ambulance to the emergency room of a regional trauma center for treatment of police reported "C" level injuries and released. The driver of the LeSabre was transported by ambulance to the emergency room of a regional trauma center for treatment of police reported "C" level injuries and released. Both vehicles were towed from the scene.

RABSS VEHICLE

The 1998 Chevrolet Cavalier was identified by the Vehicle Identification Number (VIN): 1G1JC5246W7 (production sequence omitted). The vehicle was a 4-door sedan equipped with front wheel drive and a 2.2 liter, 4 cylinder engine. The police report listed a rental car agency as the owner of the vehicle. The seating was configured with front bucket seats and a rear bench seat with a folding back.

VEHICLE DAMAGE

Exterior Damage - *1998 Chevrolet Cavalier*

The 1998 Chevrolet Cavalier sustained moderate frontal damage **(Figure 3)** as a result of the impact with the Buick LeSabre. An estimated Collision Deformation Classification (CDC) for this impact to the Cavalier was 11-FYEW-2. Direct contact damage began at the center of the bumper and extended laterally to the left bumper corner. The combined direct and induced damage length (Field L) involved the full frontal width of the vehicle. Slight lateral displacement of the LeSabre's hood resulted in paint transfers on the front center area of the Cavalier's hood. The impact also caused induced buckling of the hood and left fender. The left front wheel was restricted from sheet metal damage.

Figure 3. View showing damage across the frontal plane of the Cavalier

Interior Damage - *1998 Chevrolet Cavalier*

Interior damage to the Chevrolet Cavalier was based on a single on-scene photo **(Figure 4)**. Interior damage was attributed to occupant contact. There was no intrusion of the passenger compartment. The lower aspect of the steering wheel rim was bent forward from contact with the driver.

Exterior Damage - *1989 Buick LeSabre*

The 1989 Buick LeSabre sustained moderate right side and frontal damage as a result of the impact with the Cavalier. The estimated CDC for this impact to the LeSabre was 02-RFEW-3. The direct contact began forward of the right front wheel and extended forward to the front right bumper corner. Induced

damage included slight forward/lateral displacement of the hood, and buckling at the center of the front bumper. The backlight was shattered from impact forces.

REDESIGNED AIR BAG SYSTEM - 1998 Chevrolet Cavalier

The 1998 Chevrolet Cavalier was equipped with redesigned frontal air bags for the driver and front right passenger positions **(Figure 4)**. The air bags deployed as a result of the impact with the Buick LeSabre. The driver's air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). The driver's side air bag module was partially separated from the steering wheel hub on the lower left side with a small portion of the air bag protruding from under the module. This indicated that the driver was in close proximity to the steering wheel as the air bag deployed, which restricted the expansion of the air bag, causing partial expansion to the side of the module. No contact evidence was identified on the air bag or exterior surface of the cover flap. The cover flaps were symmetrical in shape. Two vent ports were identified approximately at the 11 o'clock and 1 o'clock positions on the air bag.

Figure 4. Interior view of the Cavalier

The front right passenger air bag deployed from the right upper-instrument panel area with a single cover flap design hinged at the top aspect. The cover flap was rectangular in shape. There was no direct intact evidence visible in the police photographs from expansion against the child passenger.

OCCUPANT DEMOGRAPHICS

Driver -*1998 Chevrolet Cavalier*

Age/Sex:	26-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Forward
Manual Restraint Use:	Unrestrained
Usage Source:	Police report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to an emergency room of a regional trauma center and released

Driver Kinematics - *1998 Chevrolet Cavalier*

The 26-year-old female driver of the Cavalier was seated in a presumed upright posture with her seat track adjusted to a forward position and the seat back set to a near vertical position (based on the on-scene police photographs). She was not restrained by the available 3-point lap and shoulder belt system. Her lack of belt usage was supported by the police crash report. In this seated position, the driver was within the deployment zone of the redesigned front left air bag. The driver may have moved forward in response to the pre-crash braking she initiated upon detection of the Buick LeSabre.

At impact, the driver was forward within the deployment zone of the front right air bag. This position impeded the normal deployment path of the expanding air bag. This was evidenced by a partial separation of the air bag module cover from the steering wheel assembly adjacent to the left spoke. The air bag membrane was visible at this point and partially extended between the cover and the spoke. The air bag fully inflated from the I-configuration module cover flaps. Due to the redesigned status of the air bag, the bag did not produce notable injury to the driver. She subsequently loaded the air bag which offered protection against the frontal crash forces. The upper steering wheel rim was deflected forward as a result of air bag expansion and driver loading.

The driver was transported by ambulance to the emergency room of a regional trauma center where she was treated for police reported "C" level injuries and released.

Front Right Passenger - *1998 Chevrolet Cavalier*

Age/Sex:	18-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Forward
Manual Restraint Use:	Unrestrained
Usage Source:	Police report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to an emergency room of a regional trauma center and released

Front Right Passenger Kinematics - *1998 Chevrolet Cavalier*

The 18-year-old female front right passenger was seated in a upright posture, holding a 2-year-old male on her lap. The seat track was adjusted to a forward position with the seat back rest adjusted to a near vertical position to accommodate the additional six child passengers in the rear seat area. The police crash report listed the female passenger as unrestrained. She probably responded to the pre-crash braking by initiating a forward trajectory. This action placed the 2-year-old child against or within a close proximity to the top mounted front right air bag module.

The deployment of the front right air bag probably displaced the child passenger into the frontal aspect of the 18-year-old. She sustained police reported "C" level injuries and was transported to the emergency room of a regional trauma center and released.

Front Right Passenger (on lap) - *1998 Chevrolet Cavalier*

Age/Sex:	2-year-old male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	N/A
Manual Restraint Use:	Unrestrained - on lap
Usage Source:	Police report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to a regional children's hospital and expired two days later

Front Right Child Passenger Injuries - *1998 Chevrolet Cavalier*

Injury	Injury Severity (AIS 90)	Injury Mechanisms
Atlanto-occipital dislocation	Moderate (650208.2,6)	Front right air bag membrane and/or module cover flap
Brain stem injury, not further specified	Critical (140299.5,8)	Front right air bag membrane and/or module cover flap

*Injury source: Death certificate

Front Right Child Passenger Kinematics - *1998 Chevrolet Cavalier*

The 2-year-old male child passenger was positioned on the lap of the 18-year-old female in the front right position of the Cavalier with the seat track adjusted to a forward position. The two occupants initiated a forward trajectory in response to the pre-crash braking. This positioned the child passenger against or within a close proximity to the top mounted front right air bag module. At impact with the Buick LeSabre, the redesigned frontal air bag system deployed as the occupants initiated a forward trajectory in response to the frontal impact force. The expanding air bag module cover flap and/or air bag membrane contacted the anterior neck and chin of the 2-year-old child passenger. The continued expansion of the air bag hyper-extended the child's head which resulted in an atlanto-occipital dislocation with a brain stem injury. The child was probably displaced rearward into the 18-year-old female passenger. It was unknown if the child passenger sustained additional injury.

He was transported by ambulance to a regional children's hospital where he was evaluated and admitted. The child expired two days following the crash. There was no autopsy performed on the body.

Rear Seat Occupants - *1998 Chevrolet Cavalier*

The rear seat of the Cavalier was occupied by six child passengers, ranging in age from 9 months to 3 years of age **(Figure 5)**. The PCR listed all of these passengers as unrestrained. The PCR further

Figure 5. Interior view of the rear seat in the Cavalier

identified the injury levels as “C-level” (possible injury). As a precautionary measure, all rear seat child passengers were transported to the emergency room of a regional trauma center where they were examined, treated if necessary, and released.