TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian
Calspan Operations
Buffalo, New York 14225

REDESIGNED AIR BAG SPECIAL STUDY (RABSS)
SCI TECHNICAL SUMMARY REPORT

NASS RABSS CASE NO. 1998-43-810G

RABSS VEHICLE - 1998 CHEVROLET CAVALIER

LOCATION - STATE OF NORTH CAROLINA

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 investigation focused on a two-vehicle crash involving a 1998 Chevrolet Cavalier 2-door coupe (subject vehicle) and a 1998 depowered Ford Explorer XL sport utility. The Chevrolet Cavalier was equipped with redesigned frontal air bags that deployed as a result of a right angle collision with the Ford Explorer. The Chevrolet was eastbound and attempted to turn left (north) at a 3-leg intersection when it crossed into the path of the southbound Ford. As the Chevrolet turned left and crossed the southbound lanes, the front of the Chevrolet struck the right passenger area of the Ford. Impact resulted in moderate damage to both vehicles. The Chevrolet came to rest in the southbound lanes facing southeast. At this point, the Ford rotated clockwise and rolled left 2 quarter turns before coming to rest (on its top) in the northbound lanes facing southwest. This secondary impact to the Ford resulted in moderate top damage. The 16 year old female driver of the Chevrolet Cavalier was properly restrained by the 3-point manual lap and shoulder belt system and initiated a forward/lateral trajectory in response to the 11 o'clock impact force, loading the manual restraint and deployed redesigned driver air bag. The driver (and four occupants of the Ford Explorer) were not injured in the collision.			
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BACKGROUND

This investigation focused on a two-vehicle crash involving a 1998 Chevrolet Cavalier 2-door coupe (subject vehicle) and a 1998 depowered Ford Explorer XL sport utility. The Chevrolet Cavalier was equipped with redesigned frontal air bags that deployed as a result of a right angle collision with the Ford Explorer. The Chevrolet was eastbound and attempted to turn left (north) at a 3-leg intersection when it crossed into the path of the southbound Ford. As the Chevrolet turned left and crossed the southbound lanes, the front of the Chevrolet struck the right passenger area of the Ford. Impact resulted in moderate damage to both vehicles. The Chevrolet came to rest in the southbound lanes facing southeast. At this point, the Ford rotated clockwise and rolled left 2 quarter turns before coming to rest (on its top) in the northbound lanes facing southwest. This secondary impact to the Ford resulted in moderate top damage. The 16 year old female driver of the Chevrolet Cavalier was properly restrained by the 3-point manual lap and shoulder belt system and initiated a forward/lateral trajectory in response to the 11 o'clock impact force, loading the manual restraint and deployed redesigned driver air bag. The driver (and four occupants of the Ford Explorer) were not injured in the collision.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-43-810G for the Redesigned Air Bag Special Study. The Field Operations Branch of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and final report preparation.

SUMMARY

Crash Site

This two-vehicle crash occurred during the evening hours of November, 1998. At the time of the crash, it was dark (street lighted) with no adverse conditions as the roads were dry. The crash occurred in the southbound lanes of an 6-lane north/south undivided asphalt roadway **(see Figure 7 - page 5)** which curved to the right for southbound traffic. Traffic control at the scene included a stop sign for eastbound traffic. The speed limit at the crash scene was 56 km/h (35 mph).

Pre-Crash

The 16 year old female driver of the 1998 Chevrolet Cavalier was operating the vehicle eastbound **(Figure 1)** on a 2-lane roadway when she stopped at the stop sign and failed to notice the Ford as she turned left (north) at a police reported speed of 24 km/h (15 mph). The 41 year old male driver of the 1998 Ford Explorer XL was operating the vehicle southbound **(Figure 2)** negotiating a right curve at a police reported speed of 56 km/h (35 mph) when he observed the Chevrolet turn left across his lane of travel. There were no brake marks

within the vehicle's trajectory indicative of driver avoidance maneuvers. The Ford was also occupied by a 37 year old female in the front right position along with a 12 year old female in the rear left position and 14 year old male in the rear right position.

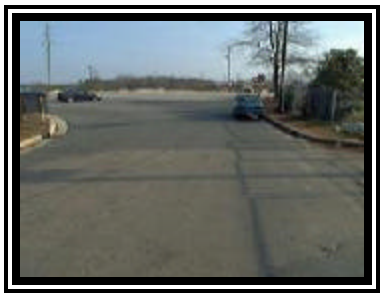

Figure 1. Eastbound approach for the 1998 Chevrolet Cavalier.

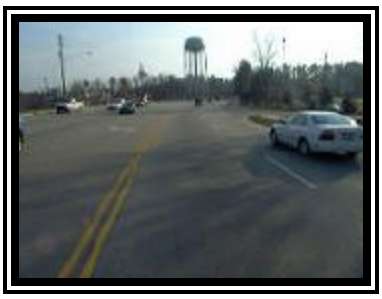

Figure 2. Southbound approach for the 1998 Ford Explorer.

Crash

As the Chevrolet crossed the southbound lanes of the 6-lane roadway, the vehicle's front struck the right passenger area of the Ford. The impact induced deceleration was sufficient to deploy the Chevrolet's redesigned frontal air bag system. The damage algorithm of the WinSMASH program computed velocity changes of 16.6 km/h (10.3 mph) for the subject vehicle and
10.5 km/h (6.5 mph) for the struck Ford. Respective longitudinal components were -12.7 km/h
(-7.9 mph) and -8.0 km/h (-5.0 mph). The Collision Deformation Classification (CDC) for this impact to the Chevrolet Cavalier was 71-FDEW-1 (PDOF incremented for lateral end shifting to the right) and 01-RPLW-2 for the Ford Explorer. The Chevrolet came to rest in the southbound lanes facing southeast. This initial impact to the Ford initiated a 2 quarter turn left side rollover resulting in moderate top damage. The Collision Deformation Classification (CDC) for this secondary impact to the Ford was 00-TDDO-3. The Ford came to rest in the northbound lanes (on its roof) facing southwest.

Post-Crash

The driver of the Chevrolet Cavalier exited the vehicle under her own power (exit status of the Ford occupants were unknown). An ambulance was summoned to the crash site but no occupants in either vehicle were transported to a local hospital for treatment. Both vehicles were towed from the scene.

RABSS VEHICLE

The 1998 Chevrolet Cavalier was identified by the Vehicle Identification Number (VIN): 1G1JC1242W7 (production sequence deleted). The vehicle was a 2-door coupe equipped with front wheel drive and a 2.2 liter, 4 cylinder engine. The vehicle's odometer reading was
1,825 km (1,134 miles) at the time of the crash. The police report listed the driver's father as the owner of the vehicle. The seating was configured with front bucket seats and a rear bench (with folding back). The driver reported no previous crashes or maintenance on the air bag system (original equipment). No cell phone was

present or in use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

Figure 3. Frontal damage to the 1998 Chevrolet Cavalier.

The Chevrolet Cavalier sustained moderate frontal damage as a result of the impact with the Ford Explorer **(Figure 3)**. The direct contact damage encompassed the full frontal width resulting in a combined direct and induced damage length (Field L) of 109.0 cm (42.9 in). Six crush measurements were documented at the level of the reinforcement bar (bumper cover separation): C1= 5.0 cm (2.0 in), C2= 14.0 cm (5.5 in), C3= 20.0 cm (7.9 in), C4= 15.0 cm (5.9 in), C5= 9.0 cm (3.5 in), C6= 6.0 cm (2.4 in). Damage was noted to the hood which was slightly displaced up and rearward from engagement against the side surface of the Ford. The end structure was displaced 11.0 cm (4.3 in) laterally to the right which restricted the right front wheel/tire (not deflated). The windshield was fractured from the (interior) front right air bag module cover flap.

Figure 4. Right side damage to the 1998 Ford Explorer.

The Ford Explorer sustained moderate right side damage as a result of the impact with the Chevrolet Cavalier **(Figure 4)**. The direct contact damage began 64.0 cm (25.2 in) aft of the right front axle and extended 172.0 cm (67.7 in) rearward. The impact resulted in a combined direct and induced damage length (Field L) of 172.0 cm (67.7.0 in). The direct contact damage was concentrated between the A and C-pillars at the level of the frame. Induced damage was noted to the upper window frame of the right rear door with no resulting integrity loss. Direct contact damage was documented to the top plane (from the rollover) which extended down the entire length of the vehicle. A maximum crush value of 24.0 cm (9.4 in) was documented to the left A-pillar. This fractured/holed the windshield and produced significant integrity loss. Additional rollover damage was noted to the right rear wheel which was restricted and flat. The left rear wheel was deflated (not restricted).

Interior Damage

Interior damage to the Chevrolet Cavalier identified through the NASS vehicle inspection was minimal and was attributed to occupant contact. A scuff mark was documented to the left door panel. No deformation was identified to the fixed steering column or knee bolster (rigid plastic type). The windshield was fractured from the front right air bag module cover flap.

REDESIGNED AIR BAG SYSTEM

The 1998 Chevrolet Cavalier was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the crash. The driver air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). The flaps were symmetrical in shape and measured 11.0 cm (4.3 in) in width and 10.0 cm (3.9 in) in height. No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The NASS researcher measured the diameter of the driver air bag at 60.0 cm (23.6 in) in its deflated state **(Figure 5)**. No internal straps were present. The bag was vented by two ports located at the 3 o'clock and 9 o'clock sectors on the rear aspect of the air bag.

Figure 5. 1998 Chevrolet Cavalier redesigned driver air bag.

Figure 6. 1998 Chevrolet Cavalier redesigned passenger air bag.

The front right passenger air bag deployed from a top mount module in the right instrument panel with a single cover flap design hinged at the forward aspect. There was no contact evidence on the air bag or exterior surface of the module cover flap which opened in an upward direction towards the windshield. The cover flap was asymmetrical in shape and measured 32.0 cm (12.6 in) in width and 27.0 cm (10.6 in) in height along the left edge of the flap and 19.0 cm (7.5 in) along the right edge. The NASS researcher measured the passenger air bag at 50.0 cm (19.7 in) in width and 58.0 cm (22.8 in) in height in its deflated state **(Figure 6)**. No tether straps or vent ports were present. No cutoff switch was reported for the front right air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	16 year old female
Height:	168 cm (66 in)
Weight:	61 kg (135 lb)
Seat Track Position:	Mid-to-forward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, surrogate interview, police report
Eyeware:	Contact lenses
Type of Medical Treatment:	None

Driver Injuries

Injury	***Severity (AIS 90)***	***Injury Mechanism***
N/A	N/A	N/A

Driver Kinematics

The 16 year old female driver of the 1998 Chevrolet Cavalier was properly restrained by the available 3-point lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-forward position. The police report noted that she was belted, further evidenced by the lack of substantial interior contacts and injury. At impact, she initiated a forward/lateral trajectory in response to the 11 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. The air bag provided additional restraint against further contact to the steering wheel hub/rim. The driver was not injured in the collision nor transported to a local hospital for treatment.

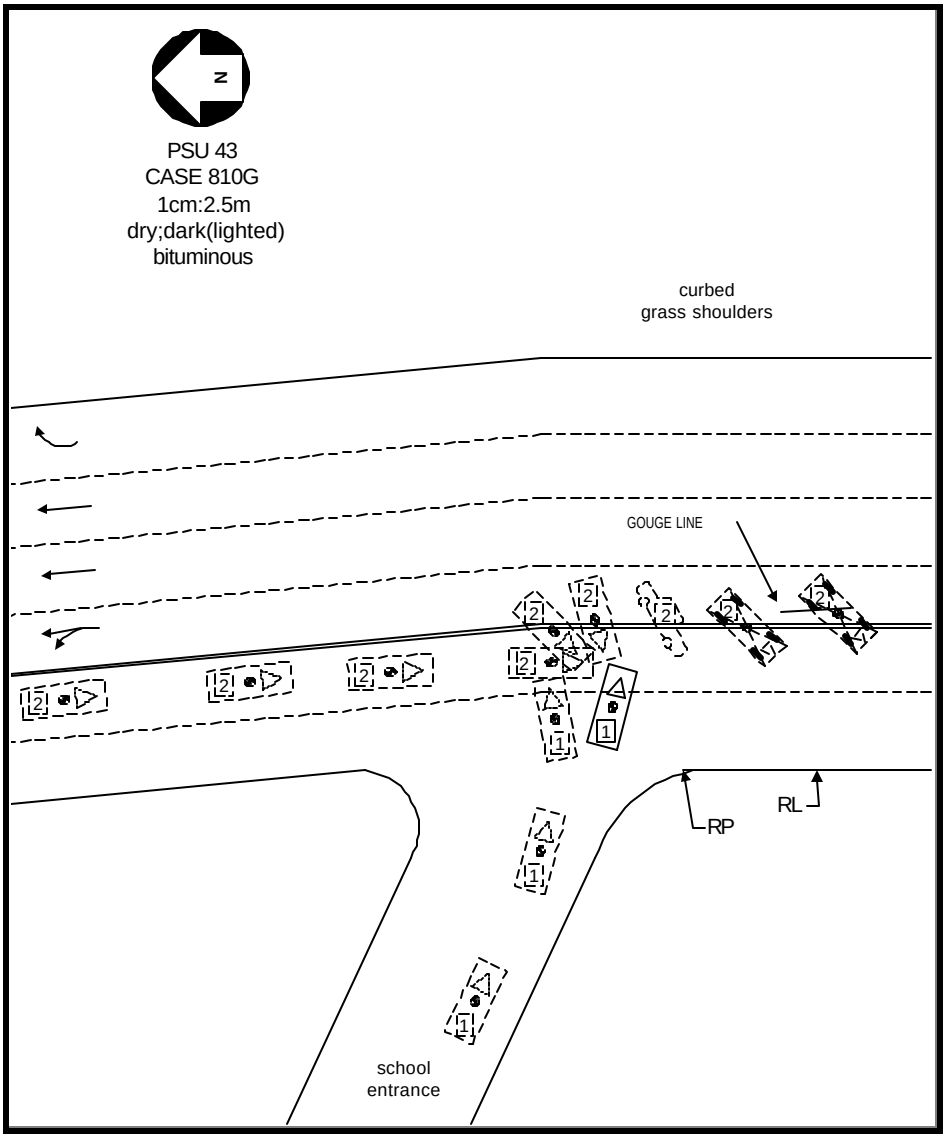

Figure 7. NASS Scene Diagram