TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian Engineering
Buffalo, New York 14225

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

NASS RABSS CASE NO. 1998-11-814E

RABSS VEHICLE - 1998 CHEVROLET CAVALIER

LOCATION - STATE OF MICHIGAN

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 1992 Ford Aerostar XL minivan. The Chevrolet Cavalier was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an offset frontal collision with the Ford Aerostar. The Ford Aerostar was stationary in the westbound lane of a two lane rural roadway in anticipation of turning left (south) at a 3-leg intersection. The frontal area of a westbound 1996 Plymouth Voyager impacted the rear area of the Ford which re-directed the Ford across the centerline and into the path of the eastbound Chevrolet Cavalier. As the Ford entered the eastbound lane, the front right area struck the front right area of the Chevrolet resulting in moderate damage to both vehicles. The restrained 47 year old female driver of the Chevrolet Cavalier initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in a contusion of the right knee. She also sustained a fracture of the right fifth finger from contact to the steering wheel rim. The Chevrolet driver was transported by ambulance to the emergency room of a local trauma center for treatment and released.			
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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 1992 Ford Aerostar XL minivan. The Chevrolet Cavalier was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an offset frontal collision with the Ford Aerostar. The Ford Aerostar was stationary in the westbound lane of a two lane rural roadway in anticipation of turning left (south) at a 3-leg intersection. The frontal area of a westbound 1996 Plymouth Voyager impacted the rear area of the Ford which re-directed the Ford across the centerline and into the path of the eastbound Chevrolet Cavalier. As the Ford entered the eastbound lane, the front right area struck the front right area of the Chevrolet resulting in moderate damage to both vehicles. The restrained 47 year old female driver of the Chevrolet Cavalier initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in a contusion of the right knee. She also sustained a fracture of the right fifth finger from contact to the steering wheel rim. The Chevrolet driver was transported by ambulance to the emergency room of a local trauma center for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-11-814E for the Redesigned Air Bag Special Study. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian the task of case review and final report preparation.

SUMMARY

Crash Site

This two vehicle crash occurred during the afternoon hours of November, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the eastbound lane of a straight and level 3-leg rural intersection which was controlled by an overhead signal system in a steady yellow (flashing) phase for east/westbound traffic **(see Figure 8 - page 5)**. The east/westbound roadway consisted of two asphalt travel lanes bordered by wide paved shoulders and private lawns. The posted speed limit at the crash scene was 72 km/h (45 mph).

Pre-Crash

The 42 year old male driver of the 1992 Ford Aerostar was stationary and faced west **(Figure 1)** in the westbound lane of the two lane rural roadway, in anticipation of turning left (south) at the 3-leg intersection. A 1996 Plymouth Voyager also traveling westbound (behind the Ford) impacted rear area of the Ford which re-directed the vehicle across the centerline and into the eastbound lane. The 47 year old female driver of the

1998 Chevrolet Cavalier was operating the vehicle eastbound **(Figure 2)** and proceeding straight when she observed the westbound Ford cross her path of travel. The Chevrolet driver reported no avoidance maneuvers in anticipation of the impending crash.

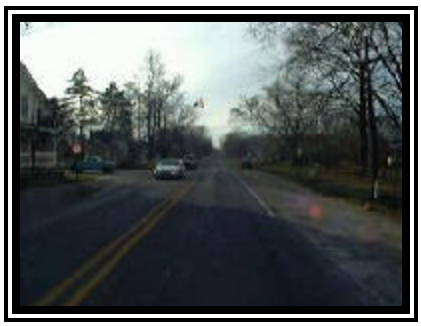

Figure 1. Westbound approach for the 1992 Ford Aerostar minivan.

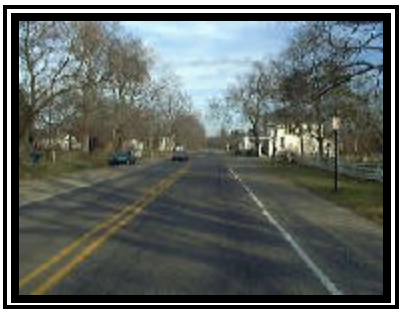

Figure 2. Eastbound approach for the 1998 Chevrolet Cavalier.

Crash

As the Ford Aerostar entered the eastbound lane of the two lane rural roadway, the front right area impacted the front right area of the Chevrolet resulting in moderate damage to both vehicles. The WinSMASH program computed velocity changes of 27.9 km/h (17.3 mph) for the subject vehicle and 20.9 km/h (13.0 mph) for the struck Ford. Respective longitudinal components were
-27.5 km/h (-17.1 mph) and -18.1 km/h (-11.2 mph). The impact induced deceleration was sufficient to deploy the Chevrolet's redesigned frontal air bag system. Both vehicles came to rest in the south sector of the intersection with the Chevrolet faced southeast and the Ford faced south.

Post-Crash

The driver of the Chevrolet exited the vehicle with some assistance from a witness. The exit status of the Ford driver was unknown. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The Chevrolet driver was transported by ambulance to the emergency room of a local trauma center for treatment and released. The Ford driver was reported by police as uninjured. Both vehicles were towed from the scene due to disabling damage.

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 18,609 km (11,563 miles) at the time of the crash. The police report did not specify the owner of the vehicle. The seating was configured with front bucket and rear bench seats (with folding backs). Previous crashes or maintenance on the air bag system were unknown.

VEHICLE DAMAGE

Exterior Damage

Figure 3. Front right damage to the 1998 Chevrolet Cavalier 2-door coupe.

The 1998 Chevrolet Cavalier sustained moderate frontal damage as a result of the impact with the Ford Aerostar **(Figure 3)**. The direct contact damage began at the front right bumper corner and extended 88.0 cm (34.6 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 131.0 cm (51.6 in). Six crush measurements were documented at the level of the bumper: C1= 4.0 cm (1.6 in), C2= 8.0 cm (3.1 in), C3= 12.0 cm (4.7 in), C4= 16.0 cm (6.3 in), C5= 34.0 cm (13.4 in), C6= 24.0 cm (9.4 in). The Collision Deformation Classification (CDC) for this impact to the Chevrolet was 12-FZEW-2 with a principal direction of force of (-)10 degrees. An indentation was noted to the right portion of the bumper attributed to the front right bumper corner of the Ford. The grille and right headlight assembly fractured and separated from the vehicle during the collision sequence. The right fender was displaced rearward which restricted the right front wheel/tire (not deflated). The hood was deformed up and rearward from the impact force. Induced buckling was noted to the roof area at the right A-pillar. Reduction in the right and left side wheelbase measured 8.0 cm (3.1 in). The windshield was fractured from (exterior) impact forces and the (interior) front right air bag module cover flap. All tempered glazing remained undamaged.

Figure 4. Front right damage to the 1992 Ford Aerostar minivan.

The 1992 Ford Aerostar minivan sustained moderate frontal damage as a result of the impact with the Chevrolet Cavalier **(Figure 4)**. The direct contact damage began at the front right bumper corner and extended 36.0 cm (14.2 in) inboard. The impact deformed the full end width resulting in a combined direct and induced damage length (Field L) of 163.0 cm (64.2 in). The CDC for this impact to the Ford was 01-FREE-3 with a principal direction of force of (+)20 degrees. The grille and right headlight assembly fractured and separated from the vehicle during the crash sequence. Additional direct contact damage was noted to the right fender area from sustained contact between the vehicles during spinout. This damage pattern deformed the fender rearward and to the left which restricted/deflated the right front wheel/tire. Reduction in the right side wheelbase measured 28.0 cm (11.0 in).

Interior Damage

Damage to the interior surfaces of the Chevrolet Cavalier were minimal and attributed to occupant contact. A scuff mark was documented on the left knee bolster (rigid plastic type). No intrusions were found in the vehicle.

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 8.0 cm (3.1 in) in width and 12.0 cm (4.7 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, a lipstick transfer was documented at the upper left quadrant of the air bag face **(Figure 6)**. The NASS researcher measured the diameter of the driver air bag at 56.0 cm (22.0 in) in its deflated state **(Figure 5)**. No internal tether straps were present. The bag was vented by two ports located at the 9 o'clock and 3 o'clock sectors on the rear aspect of the air bag.

The front right passenger air bag deployed from the right top instrument panel area with a single cover flap design hinged at the forward aspect. No contact evidence was identified on the air bag or exterior surface of the module cover flap. The cover flap was rectangular in shape and measured 31.0 cm (12.2 in) in width and 12.0 cm (4.7 in) in height. The NASS researcher measured the passenger air bag at 46.0 cm (18.1 in) in width and 66.0 cm (26.0 in) in height in its deflated state **(Figure 7)**. No vent ports or internal tether straps were present. No cutoff switch was found for the front right air bag.

Figure 5. 1998 Chevrolet Cavalier redesigned driver air bag.

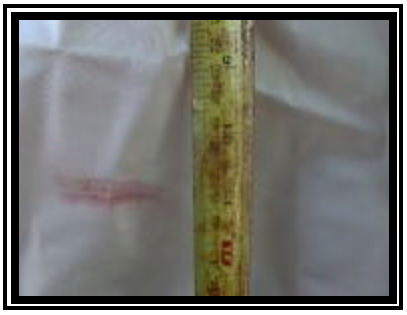

Figure 6. Lipstick transfer to the driver redesigned air bag.

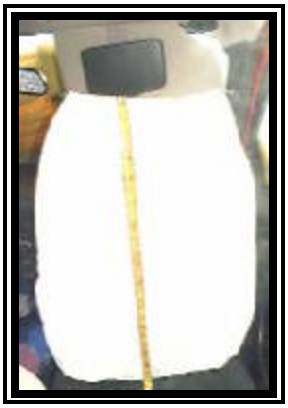

Figure 7. 1998 Chevrolet Cavalier redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	47 year old female
Height:	157 cm (62 in)
Weight:	68 kg (150 lb)
Seat Track Position:	Middle position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	NASS vehicle inspection, driver interview, police report
Eyeware:	None
Type of Medical Treatment:	Transported to the emergency room of a local trauma center and released

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Right proximal 5th finger fracture	Minor (752404.1,1)	Steering wheel rim
Right knee contusion	Minor (890402.1,1)	Left knee bolster
Right fifth dorsal finger contusion	Minor (790402.1,1)	Steering wheel rim
Scalp contusion (NFS)	Minor (190402.1,9)	Unknown source

Driver Kinematics

The 47 year old female driver of the 1998 Chevrolet Cavalier was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the middle position. Belt usage was confirmed by the lack of significant interior contacts and injury. At impact, she initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the knee bolster resulted in a contusion of the right knee as evidenced by the scuff mark documented to this component. Contact to the deployed driver air bag was confirmed by the lipstick transfer identified on the upper left quadrant of the air bag face. *Although sourced to the steering wheel rim in the NASS case file*, she also sustained a contusion and fracture of the right fifth finger which was probably an air bag "fling" type injury to an unidentified interior component. The (unspecified) scalp contusion was probably a result of contact to the driver's head restraint during the kinematic rebound, however, this could not be confirmed without a known injury aspect. The driver was transported by ambulance to the emergency room of a local trauma center for treatment and released. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury.

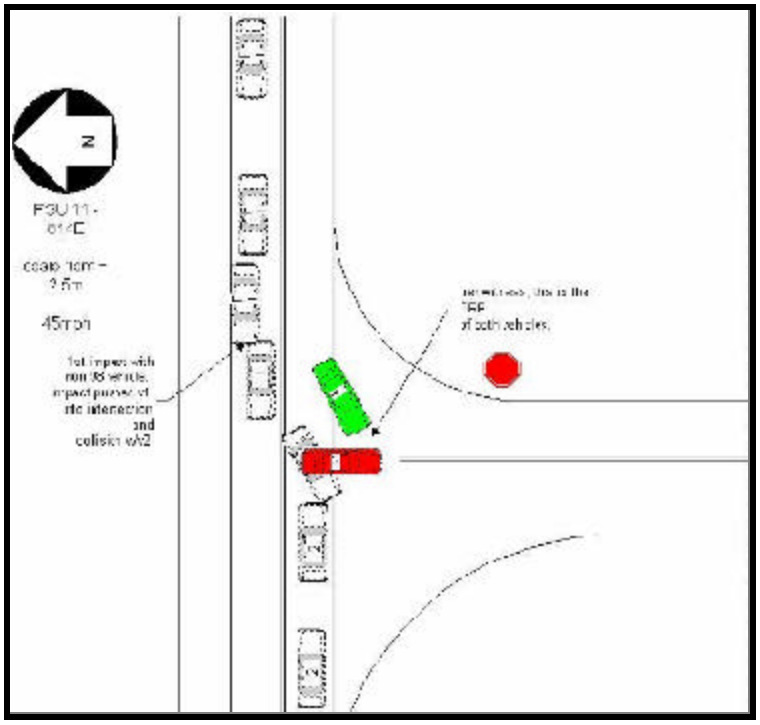

Figure 8. NASS Scene Diagram.