**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. 1998-43-804D

## RABSS VEHICLE - 1998 TOYOTA COROLLA

## LOCATION - STATE OF NORTH CAROLINA

## CRASH DATE - AUGUST, 1998

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 involving a 1998 Toyota Corolla 4-door sedan (subject vehicle) and a 1992 Geo Prizm 4-door sedan. The Toyota Corolla was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an acute angle collision with the Geo Prizm. The driver of the Geo was operating the vehicle eastbound when she failed to observe the southbound Toyota as she turned left (north) at a 3-leg intersection. As the Geo entered the intersection, the front left area of the Toyota impacted the left passenger area of the Geo resulting in minor damage to both vehicles. The restrained 45 year old female driver of the Toyota Corolla initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in a contusion to the upper left chest. Contact to the deployed redesigned driver air bag resulted in a contusion to the right cheek and a subconjunctiva hemorrhage of the right eye. The driver of the Toyota sought treatment later at a medical facility. | | | |
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## *BACKGROUND*

This investigation focused on a two vehicle crash involving a 1998 Toyota Corolla 4-door sedan (subject vehicle) and a 1992 Geo Prizm 4-door sedan. The Toyota Corolla was equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of an acute angle collision with the Geo Prizm. The driver of the Geo was operating the vehicle eastbound when she failed to observe the southbound Toyota as she turned left (north) at a 3-leg intersection. As the Geo entered the intersection, the front left area of the Toyota impacted the left passenger area of the Geo resulting in minor damage to both vehicles. The restrained 45 year old female driver of the Toyota Corolla initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in a contusion to the upper left chest. Contact to the deployed redesigned driver air bag resulted in a contusion to the right cheek and a subconjunctiva hemorrhage of the right eye. The driver of the Toyota sought treatment later at a medical facility.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-43-804D 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 August, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the southbound lane of a straight/level 3-leg (asphalt) intersection **(see Figure 8 - page 5)** which was bordered by narrow paved shoulders and a barbed wire fence located approximately 10.0 meters 32.8 feet) east of the crash site. Eastbound traffic was controlled by a stop sign with a posted speed limit of 72 km/h (45 mph).

### Pre-Crash

The 80 year old female driver of the 1992 Geo Prizm was operating the vehicle eastbound **(Figure 1)** when she stopped at the stop sign and attempted to turn left (north) at a (police reported) speed of 16 km/h (10 mph). The 45 year old female driver of the 1998 Toyota Corolla was operating the vehicle southbound on an approach to the 3-leg intersection **(Figure 2)** at a (driver reported) speed of 64 km/h (40 mph) when she observed the Geo cross her path of travel. Upon recognition of the impending harmful event, she braked in avoidance remaining in the southbound lane prior to the

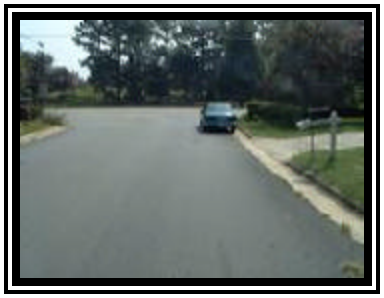

**Figure 1. Eastbound approach for the 1992 Geo Prizm.**

**Figure 2. Southbound approach for the 1998 Toyota Corolla.**

collision. *Although not documented by the NASS researcher*, this trajectory was evidenced by 13.4 meters (44.0 feet) of pre-impact brake marks identified at the scene by police.

### Crash

As the Geo Prizm crossed the southbound lane of the 3-leg intersection, the front left area of the Toyota impacted the left passenger area of the Geo resulting in minor damage to both vehicles. *Although the input data was questionable*, the damage algorithm of the WinSMASH program computed velocity changes of 17.4 km/h (10.8 mph) for the subject vehicle and 17.3 km/h (10.8 mph) for the struck Geo. Respective longitudinal components were -17.4 km/h (-10.8 mph) and -3.0 km/h (1.9 mph). The impact induced deceleration was sufficient to deploy the Toyota's redesigned frontal air bag system. At this point, the Geo rotated counterclockwise and exited the east shoulder where the back right area struck a barbed wire fence resulting in superficial damage. The Geo Prizm came to rest off the east shoulder (against the fence) facing northwest as the Toyota Corolla came to rest in the southbound lane facing south.

### Post-Crash

The driver of the Toyota Corolla exited the vehicle with some assistance from rescue personnel. The exit status of the Geo Prizm driver was unknown. Treatment was rendered at the scene by fire department personnel emergency medical technicians (EMTs). The driver of the Geo Prizm was transported by ambulance to the emergency room of a local trauma center for treatment and released as the driver of the Toyota Corolla sought treatment later at a medical facility.

## *RABSS VEHICLE*

The 1998 Toyota Corolla was manufactured on 2/98 and identified by the Vehicle Identification Number (VIN): 1NXBR12E1WZ (production sequence deleted). The vehicle was a 4-door sedan equipped with front wheel drive and a 1.4 liter, 4-cylinder engine. The vehicle's odometer reading was 10,285 km (6,391 miles) at the time of the crash. The driver was listed on the police report as the owner of the vehicle. The seating was configured with front bucket and rear bench seats. 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 Toyota Corolla.**

The 1998 Toyota Corolla sustained minor frontal damage as a result of the impact with the Geo Prizm **(Figure 3)**. The direct contact damage began at the front left bumper corner and extended 82.0 cm (32.3 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 137.0 cm (53.9 in). Six crush measurements were documented at the level of the bumper: C1= 17.0 cm (6.7 in), C2= 17.0 cm (6.7 in), C3= 11.0 cm (4.3 in), C4= 7.0 cm (2.8 in), C5= 2.0 cm (0.8 in), C6= 0. The Collision Deformation Classification (CDC) for this impact to the Toyota Corolla was 12-FYEW-2 with a principal direction of force of 0 degrees. A secondary profile was obtained above the level of the bumper. This profile was not required for this impact configuration, therefore, the crush profile was somewhat overstated. The left fender was displaced rearward which restricted the left front wheel/tire (not deflated). The hood was displaced up and rearward from engagement against the side surface of the Geo. Reduction in the left side wheelbase measured 2.0 cm (0.8 in). The windshield was fractured from the (interior) passenger air bag module cover flaps (only).

**Figure 4. Left side surface damage to the 1992 Geo Prizm.**

The 1992 Geo Prizm 4-door sedan sustained minor left side damage as a result of the impact with the Toyota Corolla **(Figure 4)**. The direct *(and induced)* contact damage began 30.0 cm (11.8 in) forward of the left rear axle and extended 65.0 cm (25.6 in) forward. The CDC for this impact to the Geo Prizm was 09-LPEW-2 with a principal direction of force of (-)80 degrees. The damage was concentrated mainly at the left rear door area with no above beltline damage noted. All glazing remained intact.

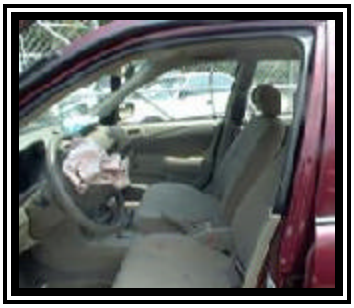

**Figure 5. Interior view of the 1998 Toyota Corolla.**

### Interior Damage

There was no damage to the interior surfaces of the Toyota Corolla from intrusions or occupant contact **(Figure 5)**.

## *REDESIGNED AIR BAG SYSTEM*

The 1998 Toyota Corolla 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 horizontally oriented flap tear seam (H-configuration). The flaps were asymmetrical in shape as the upper flap measured 16.0 cm (6.3 in) in width and 7.0 cm (2.8 in) in height while the lower flap measured 16.0 cm (6.3 in) in width

and 10.0 cm (3.9 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, skin tissue was documented on the lower right quadrant of the air bag along with dirt to the upper right quadrant. The NASS researcher measured the diameter of the driver air bag at 62.0 cm (24.4 in) in its deflated state **(Figure 6)**. The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 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 horizontally oriented flap tear seam (H-configuration). No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The cover flaps were nearly symmetrical in shape as the forward flap measured 23.0 cm (9.1 in) in width and 4.0 cm (1.6 in) in height while the aft flap measured 23.0 cm (9.1 in) in width and 6.0 cm (2.4 in) in height. The NASS researcher measured the passenger air bag at 70.0 cm (27.6 in) square in its deflated state **(Figure 7)**. No internal tether straps were present. The bag was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. No cutoff switch was found for the front right air bag.

**Figure 6. 1998 Toyota Corolla redesigned driver air bag.**

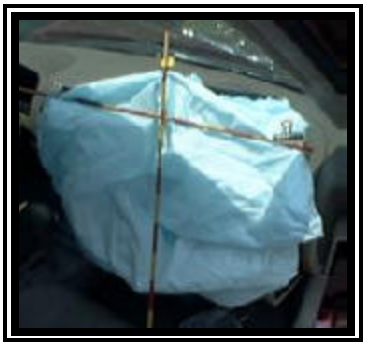

**Figure 7. 1998 Toyota Corolla redesigned passenger air bag.**

***DRIVER DEMOGRAPHICS***

| | |
|---|---|
| Age/Sex: | 45 year old female |
| Height: | 165 cm (65 in) |
| Weight: | 68 kg (150 lb) |
| Seat Track Position: | Mid-to-forward 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: | Treatment later at a medical facility |

**Driver Injuries**

| *Injury* | *Severity (AIS 90)* | *Injury Mechanism* |
|---|---|---|
| Right subconjunctiva hemorrhage | Minor (240416.1,1) | Front left air bag |
| Contusion right cheek | Minor (290402.1,1) | Front left air bag |
| Thoracic spine strain | Minor (640478.1,7) | Front left seat back |
| Abrasion left upper chest (5in) | Minor (790202.1,2) | Shoulder belt webbing |
| Abrasion left elbow ***(post-crash injury opening door)*** | Minor (790202.1,2) | Left interior door panel |
| Left forearm strain ***(post-crash injury opening door)*** | Minor (740402.1,2) | Left interior door panel |

**Driver Kinematics**

The 45 year old female driver of the 1998 Toyota Corolla was properly restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the mid-to-forward position. The driver stated during the NASS interview that she was restrained, further evidenced by the lack of significant interior contacts and injury. At impact, the driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed redesigned driver air bag. Loading of the manual restraint resulted in a contusion to the left upper chest as evidenced by the size and location of the injury. Contact to the deployed redesigned driver air bag resulted in a contusion of the right cheek and a subconjunctiva hemorrhage of the right eye, evidenced by the skin tissue documented on the lower right quadrant of the air bag face. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury. *Although erroneously included in the NASS case file*, she also sustained trauma to the right forearm which was a result of her efforts to exit the vehicle post-crash, confirmed by the interview data. She was transported later by her husband to a local hospital for treatment and released.

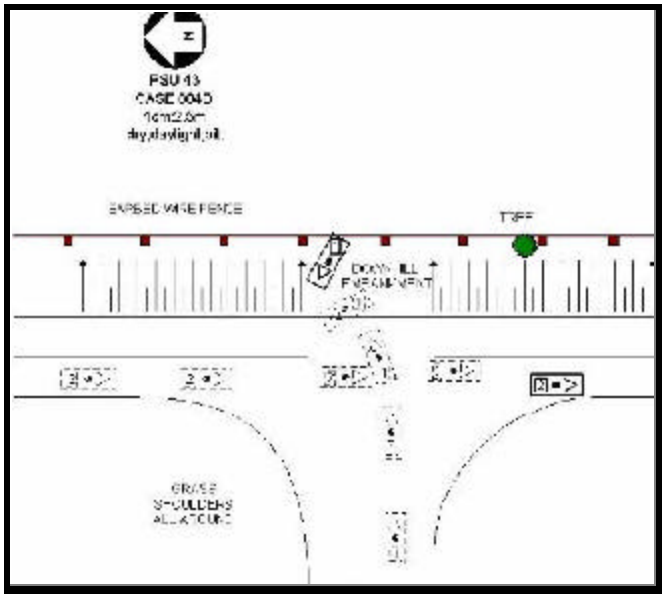

**Figure 8. NASS Scene Diagram.**