TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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

NASS RABSS CASE NO. 1998-41-801E

RABSS VEHICLE - 1998 TOYOTA COROLLA CE

LOCATION - STATE OF FLORIDA

CRASH DATE - JULY, 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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. *Report No.* 98-41-801E	2. *Government Accession No.*	3. *Recipient's Catalog No.*	
4. *Title and Subtitle* Redesigned Air Bag Special Study (RABSS) RABSS Vehicle - 1998 Toyota Corolla CE Location - State of Florida		5. *Report Date*: July, 2000 6. *Performing Organization Code*	
7. *Author(s)* Crash Research Section		8. *Performing Organization Report No.*	
9. *Performing Organization Name and Address* Transportation Sciences Crash Research Section Veridian Engineering P.O. Box 400 Buffalo, New York 14225		10. *Work Unit No.* C01115.0262.(0000-0009) 11. *Contract or Grant No.* DTNH22-94-D-07058	
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. *Type of Report and Period Covered* Technical Summary Report Crash Date: July, 1998 14. *Sponsoring Agency Code*	
15. *Supplementary Notes* NASS investigation of a frontal collision (into a fixed object) that involved a 1998 Toyota Corolla 4-door sedan equipped with redesigned frontal air bags.			
16. *Abstract* This investigation focused on a single vehicle crash involving a 1998 Toyota Corolla CE 4-door sedan equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a frontal collision with a concrete barrier. The Toyota was northbound in the center lane of a multi-lane interstate highway when the driver allowed the vehicle to depart the left (west) shoulder. As the vehicle entered the center median divider, the front left area impacted a concrete barrier resulting in moderate damage. The restrained 54 year old female driver of the Toyota Corolla initiated a forward trajectory in response to the 1 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 right chest. She also sustained a contusion and laceration of the left cheek from contact to the left front window glazing. The driver was transported to a local hospital for treatment and released.			
17. *Key Words* Redesigned frontal air bag system Collision Deformation Classification (CDC): 01-FYEW-1 Proper use of the manual belt system Left cheek contusion/laceration		18. *Distribution Statement* General Public	
19. *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 4	22. *Price*

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BACKGROUND

This investigation focused on a single vehicle crash involving a 1998 Toyota Corolla CE 4-door sedan equipped with redesigned frontal air bags for the driver and right passenger positions which deployed as a result of a frontal collision with a concrete barrier. The Toyota was northbound in the center lane of a multi-lane interstate highway when the driver allowed the vehicle to depart the left (west) shoulder. As the vehicle entered the center median divider, the front left area impacted a concrete barrier resulting in moderate damage. The restrained 54 year old female driver of the Toyota Corolla initiated a forward trajectory in response to the 1 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 right chest. She also sustained a contusion and laceration of the left cheek from contact to the left front window glazing. The driver was transported to a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as case number 98-41-801E 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 single vehicle crash occurred during the morning hours of July, 1998. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the center median divider of a straight and level multi-lane asphalt interstate highway which was divided by a raised concrete barrier **(see Figure 6 - page 4)**. The roadway was bordered by wide paved shoulders with W-beam guardrails to the east and intermittent between barrier sections in the median. No traffic control was present at the scene which had a posted speed limit of 105 km/h (65 mph).

Pre-Crash

The 54 year old female driver of the 1998 Toyota Corolla was operating the vehicle northbound **(Figure 1)** in the center travel lane at a (driver reported) speed of 105 km/h (65 mph) when she looked to the right to change lanes and allowed the vehicle to depart the left (west) shoulder. Upon recognition of the impending harmful event, the driver braked in avoidance.

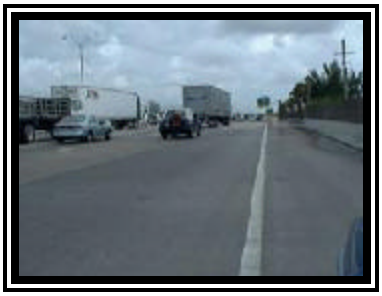

Figure 1. View north of the crash site.

Crash

As the Toyota Corolla entered the center median divider, the front left area impacted the raised concrete barrier resulting in moderate damage. The damage algorithm of the WinSMASH program computed a (barrier equivalent) velocity change of 19.2 km/h (11.9 mph) with a longitudinal components of -18.0 km/h (-11.2 mph). The impact induced deceleration was sufficient to deploy the Toyota's redesigned frontal air bag system. At this point, the vehicle rotated counterclockwise approximately 90 degrees and came to rest on the west shoulder facing south.

Post-Crash

The driver of the Toyota exited the vehicle under her own power. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). She was transported by ambulance to a local hospital for treatment and released. The Toyota was towed from the scene due to disabling damage.

RABSS VEHICLE

The 1998 Toyota Corolla CE was manufactured on 2/98 and identified by the Vehicle Identification Number (VIN): 1NXBR12E8WZ (production sequence deleted). The vehicle was A 4-door sedan equipped with front wheel drive and a 2.2 liter, 4-cylinder engine. The vehicle's odometer reading was approximately 5,311 km (3,300 miles) at the time of the crash. The police report listed the driver as the owner of the vehicle. The seating was configured with front bucket and rear bench seats (with folding backs). 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 2. Front left damage to the 1998 Toyota Corolla.

The 1998 Toyota Corolla sustained moderate frontal damage as a result of the impact with the concrete barrier **(Figure 2)**. The direct contact damage began at the front left bumper corner and extended 55.0 cm (21.7 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 130.0 cm (51.2 in). Six crush measurements were documented at the level of the reinforcement bar *(bumper fascia separation)*: C1= 21.0 cm (8.3 in), C2= 15.0 cm (5.9 in), C3= 12.0 cm (4.7 in), C4= 8.0 cm (3.1 in), C5= 1.0 cm (0.4 in), C6= 0 cm. The Collision Deformation Classification (CDC) for this impact to the Toyota was 01-FYEW-1 with a principal direction of force of (+)20 degrees. The grille and headlight assemblies fractured and separated from the vehicle during the collision sequence. The hood was displaced up and rearward from engagement against the concrete barrier. The windshield was fractured from (exterior) impact forces and the (interior) front right air bag. Reduction in the left side wheelbase measured 19.0 cm (7.5 in) while reduction in the right side wheelbase measured 4.0 cm (1.6 in). Additional direct contact damage was identified at the left front door (jammed) and fender area. This damage resembled a W-beam guardrail pattern indicative of a subsequent impact; and may necessitate assignment of another event in the NASS case file. The left fender was displaced laterally to the right with associated severe left front wheel/tire damage (restricted/deflated). Although the left front window glazing was disintegrated with direct contact damage present at the lower door area (jammed), it was probably from occupant contact given the height of the damage below the beltline.

Interior Damage

Damage to the interior surfaces of the Toyota Corolla were minimal and attributed to occupant contact **(Figure 3)**. A small indentation was identified on the left front door panel. The left front glazing was disintegrated with associated blood spattering noted to the driver redesigned air bag. No intrusions were found in the vehicle.

Figure 3. Interior view of the driver space.

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 nearly symmetrical 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 9.0 cm (3.5 in) in height. Although no contact evidence was identified on the exterior surface of the module cover flaps, blood spattering was noted across the face of the air bag, attributed to the driver's facial laceration. The NASS researcher measured the diameter of the driver air bag at 55.0 cm (21.7 in) in its deflated state **(Figure 4)**. 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 rectangular in shape as the forward flap measured 23.0 cm (9.1 in) in width and 3.0 cm (1.2 in) in height while the aft flap measured 23.0 cm (9.1 in) in width and 7.0 cm (2.8 in) in height. The NASS researcher measured the passenger air bag at 70.0 cm (27.6 in) in width and 60.0 cm (23.6 in) in height 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 side aspect of the air bag. No cutoff switch was found for the front right air bag.

Figure 4. 1998 Toyota Corolla redesigned driver air bag.

Figure 5. 1998 Toyota Corolla redesigned passenger air bag.

DRIVER DEMOGRAPHICS

Age/Sex:	54 year old female
Height:	170 cm (67 in)
Weight:	66 kg (146 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 a local hospital and released

Driver Injuries

Injury	*Severity (AIS 90)*	*Injury Mechanism*
Left cheek laceration (3.5cm)	Minor (290602.1,2)	Left front window glazing
Left cheek contusion	Minor (290402.1,2)	Left front window glazing
Right chest contusion	Minor (490402.1,1)	Shoulder belt webbing
Right knee contusion (posterior)	Minor (890402.1,1)	Seat cushion
Right knee contusion (anterior)	Minor (890402.1,1)	Left knee bolster

Driver Kinematics

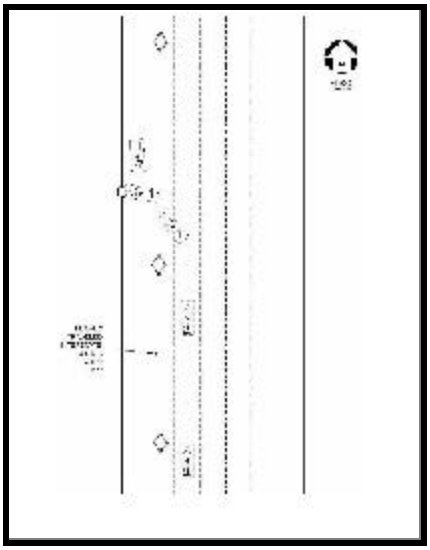

Figure 6. NASS Scene Diagram.

The 54 year old female driver of the 1998 Toyota Corolla 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. Her hands were placed at the 8 o'clock and 5 o'clock sectors on the steering wheel rim. Belt usage was confirmed by the lack of significant interior contacts and injury. At impact, the driver initiated a forward trajectory in response to the 1 o'clock impact force and loaded the manual restraint, knee bolster and deployed redesigned driver air bag. Loading of the manual restraint resulted in a right chest contusion. Loading of the knee bolster resulted in a right knee contusion. These injury mechanisms were evidenced by the location of the injuries relative to the kinematic response pattern. *Although sourced to the steering wheel rim in the NASS case file*, she also sustained a contusion/laceration of the left cheek which was probably a result of contact to the left front window glazing during subsequent vehicle spinout or guardrail impact described in the vehicle damage section. This trajectory was evidenced by the small indentation identified on the left door panel and lack of sufficient damage height to the exterior door panel area in conjunction with the blood spattering pattern across the face of the driver air bag. The driver was transported by ambulance to a local hospital for treatment and released. The combination of restraint options provided protection against further contact to the steering wheel hub/rim and potential serious injury.