

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

**Calspan Corporation
Buffalo, New York 14225**

CALSPAN ON-SITE DEPOWERED AIR BAG DEPLOYMENT INVESTIGATION

CALSPAN CASE NO. CA98-017

VEHICLE - 1998 TOYOTA CAMRY

LOCATION - NORTH CAROLINA

CRASH DATE - JANUARY, 1998

Contract No. DTNH22-94-07058

Prepared for:

**U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, DC 20590**

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be 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 of the involved vehicle(s) or their safety systems.

TECHNICAL REPORT STANDARD TITLE PAGE

<p>1. <i>Report No.</i> CA98-017</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>5. <i>Title and Subtitle</i> Calspan Depowered Air Bag Deployment Investigation Vehicle - 1998 Toyota Camry Location - North Carolina</p>		<p>4. <i>Weights</i></p>	
		<p>6. <i>Report Date:</i> August, 1998</p>	
<p>8. <i>Author(s)</i> Crash Research Section</p>		<p>7. <i>Performing Organization Code</i></p>	
		<p>9. <i>Performing Organization Report No.</i></p>	
<p>10. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Research Section Calspan Corporation P.O. Box 400 Buffalo, New York 14225</p>		<p>11. <i>Work Unit No.</i> 1115 (8410-8419)</p>	
		<p>12. <i>Contract or Grant No.</i> DTNH22-94-D-07058</p>	
<p>13. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, DC 20590</p>		<p>14. <i>Type of Report and Period Covered</i> Technical Report Crash Date: January, 1998</p>	
		<p>15. <i>Sponsoring Agency Code</i></p>	
<p>16. <i>Supplementary Notes</i></p>			
<p>17. <i>Abstract</i></p> <p>This on-site investigation focused on the injury mechanisms of a 1998 Toyota Camry involved in an off-set frontal crash with a 1983 Buick Regal. The Toyota Camry was equipped with a Supplemental Restraint System (SRS) that consisted of depowered driver and front passenger air bags that deployed as a result of the crash. The restrained female driver of the Toyota suffered AIS 1 level injuries that consisted primarily of contusions attributed to contact with the manual 3-point restraint system and knee bolster.</p> <p>This three vehicle crash occurred in the afternoon hours of January 1998. At the time of the crash, it was dusk and the weather was cloudy. The roads were reportedly wet. The crash occurred at the rural intersection of an east/west two lane state route and a north/south two lane local roadway. The intersection was controlled by stop signs for the north/south road.</p> <p>The 1998 Toyota Camry was westbound on the approach to the intersection, driven by a 26 year female. The 1983 Buick Regal was eastbound on the approach to the intersection traveling behind a 1991 Chevrolet Camaro. Immediately prior to the crash, the Chevrolet began to slow for stopped traffic at the intersection. The Chevrolet driver stated to the investigating police officer she saw the Buick approaching from behind and attempted to clear the road by driving her vehicle toward the private driveway on the right (south) side of the road. The Buick failed to keep assured clear distance ahead and reacted to the slowing Chevrolet by steering to the left. The Buick went left of center and entered the westbound lane of the road directly in the path of the Toyota. The left front of the Buick struck the left front of the Toyota in an off-set frontal collision. The 12 o'clock direction of the impact force deployed the SRS in the Toyota.</p>			
<p>18. <i>Key Words</i> Supplemental Restraint System Air bag deployment Off-set frontal crash Minor (AIS 1) injuries</p>		<p>19. <i>Distribution Statement</i> General Public</p>	
<p>20. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>21. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>22. <i>No. of Pages</i> 6</p>	<p>23. <i>Price</i></p>

TABLE OF CONTENTS

BACKGROUND 1

SUMMARY 1

AIR BAG VEHICLE 3

INTERIOR DAMAGE 3

MANUAL RESTRAINT SYSTEM 4

SUPPLEMENTAL MANUAL RESTRAINT SYSTEM 4

DRIVER INJURIES 5

DRIVER KINEMATICS 6

CALSPAN ON-SITE DEPOWERED AIR BAG DEPLOYMENT INVESTIGATION
VEHICLE: 1998 TOYOTA CAMRY
CALSPAN CASE NO. CA98-017
LOCATION: NORTH CAROLINA
CRASH DATE: JANUARY, 1998

BACKGROUND

This on-site investigation focused on the injury mechanisms of a 1998 Toyota Camry involved in an off-set frontal crash with a 1983 Buick Regal. The Toyota Camry was equipped with a Supplemental Restraint System (SRS) that consisted of depowered driver and front passenger air bags that deployed as a result of the crash. The restrained female driver of the Toyota suffered AIS 1 level injuries that consisted primarily of contusions attributed to contact with the manual 3-point restraint system and knee bolster. The Field Branch Office of the National Highway Traffic Safety Administration (NHTSA) was informed of the crash through the GES system on March 17, 1998 and assigned an investigation to the Special Crash Investigations Team at Calspan on the same day.

SUMMARY

This three vehicle crash occurred in the afternoon hours of January 1998. At the time of the crash, it was dusk and the weather was cloudy. The roads were reportedly wet. The crash occurred at the rural intersection of an east/west two lane state route and a north/south two lane local roadway. The intersection was controlled by stop signs for the north/south road. There was a private drive east of the intersection that intersected the primary road from the south. The road grade was an estimated -5% in the eastbound direction. The hillcrest was located approximately 46 m (150 ft) west of the point of impact. The point of impact was identified by a 0.5 m (1.7 ft) gouge mark located in the center of the westbound lane. The speed limit in the area of the crash was 89 km/h (55 mph). **Figures 1 and 2** are the westbound and eastbound trajectory views respectively.



Figure 1: Westbound trajectory view 30 m (100 ft) from the POI.



Figure 2: Eastbound trajectory view 30 m (100 ft) from the POI.

The 1998 Toyota Camry was westbound on the approach to the intersection, driven by a 26 year female. The 1983 Buick Regal was eastbound on the approach to the intersection traveling behind a 1991 Chevrolet Camaro. Immediately prior to the crash, the Chevrolet began to slow for stopped traffic at the intersection. The Chevrolet driver stated to the investigating police officer she saw the Buick approaching from behind and attempted to clear the road by driving her vehicle toward the private driveway on the right (south) side of the road. The Buick failed to keep assured clear distance ahead and reacted to the slowing Chevrolet by steering to the left. The Buick went left of center and entered the westbound lane of the road directly in the path of the Toyota. The left front of the Buick struck the left front of the Toyota in an off-set frontal collision. The 12 o'clock direction of the impact force deployed the SRS in the Toyota.

The Toyota Camry sustained 67.3 cm (26.5 in) of direct contact damage to the center and left portions of the front plane (**Figures 3 and 4** below). The direct damage began 21.6 cm (8.5 in) left of center and extended to the left front bumper corner. The measured crush profile was as follows: C1=55.9 cm (22.0 in), C2=55.9 cm (22.0 in), C3=38.1 cm (15.0 in), C4=25.4 cm (10.0 in), C5=17.8 cm (7.0 in), C6=0. The right front corner of the vehicle was displaced laterally to the left 17.8 cm (7.0 in). The windshield was fractured and the left front window glazing shattered in the impact. The left front suspension deformed rearward foreshortening the left side wheelbase 21.6 cm (8.5 in). Rearward deformation of the left A-pillar buckled the roof. The left side doors were jammed shut and buckled. The Collision Deformation Classification (CDC) of the Toyota was 12-FYEW-3. The barrier model of the SMASH program calculated the delta V of the Toyota to be approximately 29.1 km/h (18.1 mph). This calculated value appears low. The nature and extent of the vehicular damage is more consistent with a delta V of 32-39 km/h (20-24 mph) based on SCI experience.



Figure 3: Front view of the Toyota Camry.

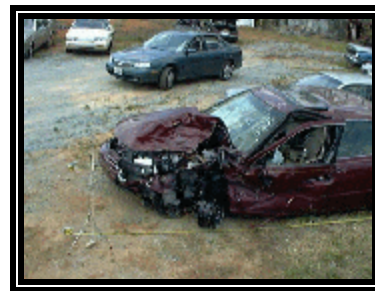


Figure 4: Left lateral view across the front plane.

The owner of the 1983 Buick Regal was uncooperative and the vehicle was unavailable for inspection. At the inspection of the Toyota, the Buick's front bumper was located in the occupant compartment of the vehicle. The displaced bumper exhibited 109 cm (43 in) of deformation and maroon paint transfer along 163 cm (64 in) of the bumper's width (Figure 5). The damage began 28 cm (11 in) right of center and extended to the left bumper corner.

After impact the Toyota rotated counterclockwise and slid to rest in the northwest quadrant of the intersection facing southward. The Buick rotated counterclockwise and had a secondary impact with the Chevrolet Camaro. The right rear quarterpanel of the Buick struck the back plane of the Chevrolet in a probable 3 o'clock/6 o'clock impact configuration. The Chevrolet was displaced forward and came to rest in the private drive west of the intersection. The Buick continued to rotate CCW and came to rest in the eastbound lane facing northward. The Toyota and Buick sustained disabling damage and were towed from the scene. The Chevrolet sustained minimal damage and was driven from the scene.



Figure 5: View of the Buick Regal's front bumper.

The 26 year old female driver of the Toyota reportedly had a height/weight of 168 cm (66 in) and 77 kg (170 lb). In her interview, the driver was initially reluctant to give any information in support of this study and declined to sign the medical release form. However, she did eventually volunteer some information regarding the facts of the crash and her injuries. The driver indicated that her seat was positioned between mid and rear track and that she was restrained by the vehicle's manual 3-point restraint system. Immediately prior to the crash, she was aware of two eastbound vehicles stopping at the intersection. However, she did not see the Buick Regal enter her lane until the time of the impact. She was unable to make any pre-impact maneuvers. Upon impact, the forces of the crash caused the Toyota's SRS to deploy. The driver initiated a forward trajectory in response to the 12 o'clock direction of the impact, loaded the 3-point restraint and contacted the deployed driver air bag. The driver reportedly suffered only AIS 1 level injuries that consisted of bruising and several superficial lacerations. She removed herself from the vehicle and waited for medical attention. The 64 year old male driver of the Buick Regal was unrestrained and suffered incapacitating injuries. The 39 year old female driver of the Chevrolet Camaro was not injured in the crash.

AIR BAG VEHICLE

The 1998 Toyota Camry was identified by a Vehicle Identification Number (VIN) of 4T1BG22K4WU (production sequence deleted). The vehicle's power train consisted of a 2.2 liter, I-4 engine linked to a 4-speed automatic transmission. Additional safety equipment included a 4-wheel anti-lock braking system. It was not possible to read the electronic odometer due to damage to the vehicle's electrical system.

The vehicle's cloth interior was tan in color. The left front seat was jammed due the deformation of the left front door. Measurements taken from an exemplar vehicle determined the seat was located approximately 5 cm (2 in) forward of full rear, 15 cm (6 in) rear of the most forward position. The horizontal distance from the seat back to the center hub of the steering wheel was 48 cm (19 in). The anti-submarine angle of the seat cushion was measured as 10 degrees. The seat back was reclined 20 degrees, measured in the center of the seat back cushion. The adjustable head restraint was in the full down position. There were no seat performance failures.

INTERIOR DAMAGE

Passenger compartment integrity was lost through the left front side window which shattered in the impact. Two specific areas of contact were identified on the left knee bolster as a result of the driver contact. These scuffs measured approximately 5 cm x 5 cm (2 in x 2 in) and were located on the bolster panel directly below the steering wheel. The center of the left and right scuffs were located 38 cm (15 in) and 18 cm (7 in) left of the vehicle's centerline respectively. The stalk of the wiper control located on the right side of the steering column was fractured most likely from right hand/forearm contact.

MANUAL RESTRAINT SYSTEM

The Toyota was equipped with 3-point lap and shoulder belt systems in all 5 seated positions (2 front and 3 rear). The front seat belt systems consisted of a continuous loop lap and shoulder belt webbing with a sliding latch plate. An inertia activated locking retractor was located in the base of each B-pillar. The front restraints were also equipped with pretensioners that were activated as a result of the crash. The restraint's upper anchorages (D-rings) were adjustable. The left front D-ring was adjusted 4.6 cm (1.8 in) above the full down position. At inspection, the left front restraint webbing was extended and the retractor was locked by the pretensioner. Examination of the latch plate indicated routine usage marks consistent with vehicle age. Examination of the webbing revealed witness marks indicative of belt usage in this crash. The right front restraint webbing was stowed and taut, locked in place by its pretensioner.

SUPPLEMENTAL RESTRAINT SYSTEM

The Toyota was equipped with a Supplemental Restraint System (SRS) that consisted of depowered air bags for the driver and right front passenger. There were no identifiers on the vehicle that indicated the SRS was a depowered system. The driver air bag module was located in the typical manner in the center hub of the tilt steering wheel (Figures 6 and 7). The steering wheel was positioned in the full down position. There was no steering wheel rim deformation or movement of the steering column's shear capsules. The H-configuration air bag module opened as designed at the designated tear points during the deployment sequence. The width of the horizontal seam measured 16.5 cm (6.5 in). The height of the upper and lower flaps measured 5.8 cm (2.3 in) and 7.6 cm (3.0 in) respectively. The following nomenclature was embossed on the interior surface of the upper flap: 081W 45112 0801. The date code of 12/13/97 was embossed on the interior surface of the lower flap.



Figure 6: Front interior view.



Figure 7: Driver air bag.

There was no contact evidence on the driver air bag. The driver air bag measured 63.5 cm (25.0 in)

in diameter in its deflated state. The bag was tethered by two 9.7 cm (3.8 in) wide straps. The bag was vented by two 2.5 cm (1.0 in) diameter ports located on the back side in 11 and 1 o'clock sectors. The back side of the air bag was stamped with the following nomenclature in the 12 o'clock sector:

45-165-06040

0005538

R039 R039

08 10 97

Assembled in Mexico

with USA components

A571C6253

The passenger air bag was configured as a top-mount design located in the right instrument panel. The air bag module cover flap was a single vinyl flap that hinged on the aft aspect of the top of the instrument panel (refer to Figure 6). The flap was trapezoidal in shape and measured 21.6 cm (8.5 in) in width. The inboard and outboard heights of the flap were 8.6 cm (3.4 in) and 5.8 cm (2.3 in) respectively. The passenger air bag was tethered by a single wide strap sewn to the face of the bag. The bag vented internally back through the air bag module. The air bag extended approximately 61 cm (24 in) from the instrument panel in its deflated state. The face of the deflated bag measured 51 cm (20 in) by 51 cm (20 in) width by height. There was no contact evidence on the air bag.

DRIVER INJURIES

Injury	Severity (AIS 90)	Injury Mechanism
Contusion - Nose	Minor (290402.1,4)	Deployed depowered driver air bag
Neck Strain	Minor (640278.1,6)	Impact force/restraint loading
Contusion - left shoulder	Minor (790402.1,2)	Inertial loading of 3-point restraint
Contusion - abdomen	Minor (590402.1,4)	Inertial loading of 3-point restraint
Contusion - right knee	Minor (890402.1,1)	Knee bolster
2.5 cm (1 in) laceration - right knee	Minor (890602.1,1)	Knee bolster
Contusion - left knee	Minor (890402.1,2)	Knee bolster
Contusion - right ankle	Minor (890402.1,1)	Foot controls
Superficial lacerations - left forearm	Minor (790600.1,2)	Shattered left side window glazing

NOTE: the above injuries were identified through an interview with the driver.

DRIVER KINEMATICS

The driver of the Toyota Camry was reportedly 26 years old and had a height/weight of 168 cm (66 in) and 77 kg (170 lb) respectively. Immediately prior to impact, she was seated in an upright position with her seat adjusted in a mid to rear track position (5 cm (2 in) forward of full rear). She was restrained by the manual 3-point restraint system. There were no pre-impact avoidance maneuvers.

At impact, the depowered SRS of the Toyota deployed and the pretensioners in the front restraint systems activated. The pretensioners removed any slack in the restraint's webbing and the restraint cinched down on the driver. The driver responded to the 12 o'clock direction of the impact force by initiating a forward trajectory and loading the restraint. This inertial loading caused the contusions of the left shoulder and abdomen and contributed to the neck strain. The forces of the impact shattered the left front glazing causing the superficial lacerations to the left forearm. The deploying air bag expanded against the anterior aspect of the driver's wrists and displaced the her hands from the steering wheel. Her right hand most likely was displaced into, and fractured, the wiper control stalk. This contact reportedly did not produce an injury to the driver. The driver's thoracic and facial areas contacted the deployed air bag causing a contusion on the nose.. The anterior aspect of her knees contacted and scuffed the knee bolster on both sides of the steering column causing the knee contusions and minor right knee laceration. During the forward kinematic pattern, the driver's right ankle most likely contacted the foot controls causing the contusion at that location. The driver then rebounded back into the seat.