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CRASH DATA RESEARCH CENTER

Veridian Engineering
Buffalo, NY 14225

AIR BAG RELATED CHILD PASSENGER SERIOUS INJURY INVESTIGATION

VERIDIAN CASE NO.: CA02-058

VEHICLE: 1995 TOYOTA CAMRY

LOCATION: NEW YORK

CRASH DATE: NOVEMBER 2002

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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 on-site investigation focused on the injuries, injury severity and the injury mechanisms for a 23 month old male child passenger seated unrestrained in the front right position in a 1995 Toyota Camry. The Toyota was involved in a minor severity intersection crash with a 1997 Ford F150 pick-up truck. The Toyota Camry was equipped with a Supplemental Restraint System that consisted of frontal air bags for the driver and front right passenger that deployed as a result of the impact. The unrestrained child sustained a right lung contusion as a result of contact with the deploying front right air bag module cover flap and was hospitalized at a regional trauma center. The 27 year old male driver of the Toyota and the 73 year old male driver of the Ford were not injured in the crash. The Special Crash Investigation (SCI) team at Veridian Engineering identified this crash through the local news media and subsequently notified the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA). NHTSA assigned an on-site investigation of the crash November 21, 2002. Cooperation with the investigating police department was established and the vehicles were available for SCI inspection.			
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BACKGROUND

This on-site investigation focused on the injuries, injury severity and the injury mechanisms for a 23 month old male child passenger seated unrestrained in the front right position in a 1995 Toyota Camry. The Toyota was involved in a minor severity intersection crash with a 1997 Ford F150 pick-up truck. The Toyota Camry was equipped with a Supplemental Restraint System that consisted of frontal air bags for the driver and front right passenger that deployed as a result of the impact. The unrestrained child sustained a right lung contusion as a result of contact with the deploying front right air bag module cover flap and was hospitalized at a regional trauma center. The 27 year old male driver of the Toyota and the 73 year old male driver of the Ford were not injured in the crash.

The Special Crash Investigation (SCI) team at Veridian Engineering identified this crash through the local news media and subsequently notified the Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA). NHTSA assigned an on-site investigation of the crash on November 21, 2002. Cooperation with the investigating police department was established and the vehicles were held for SCI inspection.

SUMMARY

Crash Site

This two-vehicle crash occurred during daylight hours in November 2002. At the time of the crash, it was snowing and the road surface was wet. The crash occurred at the four-leg intersection of a two lane north/south road and a two lane east/west road in an urban residential setting. Residential housing bordered the east side of the road. The intersection was controlled by a stop sign for traffic in the east/west direction. The speed limit in the area of the crash was 56 km/h (35 mph). **Figure 1** is a southbound trajectory view approximately 30 m (100 ft) north of the intersection.

Figure 1: Southbound trajectory view.

CRASH SEQUENCE

Pre-Crash

On the day of the crash, the 1995 Toyota Camry was driven by a 27 year old unrestrained male and his 23 month old son who was seated unrestrained in the vehicle's front right position. The vehicle was stopped at a check point operated by the city's police department as part of the New York State *"Click It or Ticket"* safety belt campaign. The police officer observed the unrestrained driver and noted the 2 year old unrestrained child passenger. The officer issued the driver four citations and lectured the driver regarding the risks of child passengers and air bags. He was instructed to place the child in the rear seat, restrain the child, and to use a child safety seat. The driver stated he was on the way to drop off the child at a day care center and had a child safety seat at home. He further stated that he would comply with the officer's request. At this point, the officer returned to the check point and the driver drove away. The police officer did not observe the driver reposition or restrain the child in the vehicle.

Approximately twenty minutes later, the Toyota was traveling south on the subject road. Coincident to this, a 74 year old restrained male was operating the 1997 Ford F150 pick-up truck westbound on the intersecting road. The Ford stopped at the stop sign and then accelerated forward directly into the path of the Toyota. The driver of the Toyota braked in an attempt to avoid the impending crash.

Crash

The front plane of the Toyota struck and under-rode the right side plane of the Ford in a T-configuration impact. The delta V experienced by the Toyota in the impact was calculated top be 17.0 km/h (10.6 mph). The impact induced deceleration of the crash was sufficient to cause the deployment of the Toyota's frontal air bags.

The lateral momentum of the Ford (with respect to the Toyota) redirected the Camry to the southwest. The Ford initiated a clockwise rotation and came to rest facing northwestward approximately 7.6 m (25.0 ft) from the impact. The Toyota came to rest facing southwest approximately 6.1 m (20.0 ft) from the point of impact. Both vehicles came to rest on the road, within the intersection.

The on-scene police investigation did not find any physical evidence related to the crash due to the wet road conditions. The area of impact and the vehicles' final rest locations were not documented. No physical evidence was identified during the subsequent SCI scene inspection. A generalized schematic of the crash sequence is depicted as **Figure 11** at the end of this report.

Post-Crash

Immediately after the crash, the uninjured driver (father) of the Toyota exited the vehicle and removed the child from the Camry's front right passenger seat. He flagged down a passing motorist and they were transported to a local hospital located within 2 km (1 mile) of the crash scene. The father carried the child into the emergency room and he related the circumstances of the crash. The child was unconscious and unresponsive at that time. He was noted to be bleeding about the mouth. The child was intubated and diagnostic tests were conducted to determine the extent and nature of his injury. Radiology revealed a right lung contusion and the potential of a closed head injury was noted. A self-inflicted tongue laceration was observed to

be the source of the blood in the mouth.

Due to the seriousness of his injury, the child was immediately transported via ambulance to a level 1 pediatric trauma center located within the city limits. The child was admitted into the pediatric intensive care unit (PICU) and was listed in guarded condition approximately 4 hours post-crash. The child was extubated on hospitalization day three. The child's pulmonary injury improved over the course of his admission and he was transferred to the general pediatric floor on day eight for rehabilitation. At that time, the child's gait was noted to be wobbly and he did not want to use his upper extremities. These deficits were thought to be the aftereffects of a concussion. Diagnostic tests of the brain, brain stem and cervical spine were negative. The child remained hospitalized on the general pediatric floor an additional 17 days.

1995 TOYOTA CAMRY LE

The 1995 Toyota Camry LE, **Figure 2**, was identified by the Vehicle Identification Number 4T1GK12E9SU (production sequence deleted) and was manufactured in April 1995. The vehicle was equipped with a 3.0 liter, V-6 engine linked to a four speed automatic transmission. The manual restraint system consisted of 3-point lap and shoulder belts in the four outboard positions. The center rear position was equipped with a lap belt. The Supplemental Restraint System consisted of driver and front right passenger air bags that deployed as a result of the impact. The odometer read 158,887 km (98,730 miles) at the time of the inspection.

Figure 2: Left front view of the Toyota.

Exterior Damage

Figures 3 and 4 are the front and left lateral views of the frontal damage. The front plane of the Toyota sustained 119 cm (47 in) of direct contact damage that began 43 cm (17 in) right of center and extended to the left front corner. The combined width of the direct and induced damage extended across the vehicle's entire 152 cm (60 in) end width. The residual crush profile of the Toyota was measured along the bumper reinforcement bar and the upper radiator support to document the vehicle's direct frontal and underride engagement. The averaged crush profile used as the input to the WINSMASH model to estimate the crash severity was as follows: C1=6 cm (2.3 in), C2=6 cm (2.3 in), C3=6 cm (2.3 in), C4=7 cm (2.9 in), C5=6 cm (2.3 in), C6=0. The hood was buckled and veed. There was no measurable reduction in the wheelbase dimensions. All the doors remained operational. There were no glazing fractures and the windshield was intact. The Collision Deformation Classification was 11-FDEW-1. The total delta V of the Toyota calculated by the Damage Only Algorithm of the WINSMASH model was 17.0 km/h (10.6 mph). The longitudinal and lateral delta V components were -16.0 km/h (-9.9 mph) and 5.8 km/h (3.6 mph), respectively.

Figure 3: Front view.

Figure 4: Left lateral view.

1997 FORD F150 PICK-UP TRUCK

The 1997 Ford F150 Pick-up was identified by the Vehicle Identification Number (VIN): 1FTDX18W5VC (production sequence deleted). The Ford was a three door, super cab model manufactured with a 399 cm (157 in) wheelbase. The vehicle had a gross weight rating of 2,835 kg (6,250 lb). The power train consisted of a 4.6 liter, V-8 engine linked to a 4-speed automatic transmission. The manual restraint system consisted of 3-point lap and shoulder safety belts in the four outboard positions and a center rear lap belt. The Supplemental Restraint System consisted of driver and front right passenger air bags with a cut-off switch. There was no deployment of the frontal air bags in this side impact crash.

Figure 5 is a front right view of the minor impact damage. The initial contact was approximately centered on the right door and resulted in a maximum measured crush of 10 cm (4 in). Inspection of the vehicle undercarriage revealed a direct contact scuff to the right frame rail. The length of this contact measured 30 cm (12 in). There was no lateral deformation of the rail. As the Ford traveled laterally across the front of the Toyota, the secondary contact extended rearward to the leading edge of the rear wheel well. The secondary damage consisted of minor scratches and abrasions to the body panel. The Collision Deformation Classification (CDC) of the impact was 02-RPEW-2.

Figure 5: Right front view.

1995 TOYOTA CAMRY

Interior Inspection

The Toyota's interior damage was consistent with the minor magnitude of the crash. There was no intrusion or interior damage associated to the exterior crash forces. All the interior damage was associated to the deployment of the vehicle's Supplemental Restraint System and interior contacts from the child passenger. There was no contact evidence identified on either (driver's or front right passenger) knee bolster and there was no deformation of the steering wheel rim. There was no displacement of the steering column's shear capsules.

The driver of the Toyota reportedly had removed his personal possessions from the vehicle prior to the SCI inspection. The front bucket seats were located in a full rear track position and may have been moved to that position. The at-crash position of the seats could not be verified. The driver seat back was reclined 37 degrees aft of vertical. The horizontal distance from the center of the steering wheel to the driver's seat back measured 80.0 cm (31.5 in). The front right seat back was reclined 35 degrees. The horizontal distance from the seat back to the instrument panel measured 101.9 cm (40.1 in). The vehicle had been equipped with a custom TV/DVD installation. This equipment was removed by the driver. The electronics were mounted in the center radio stack, **Figure 6**. Reportedly, the TV was a small flat screen mounted on a swivel/fold down base located on the top of the instrument panel. The driver of the Ford F150 reported that the Toyota's driver and child passenger were watching the TV at the time of the crash.

Figure 6: Center instrument panel.

Manual Restraint System

The 1995 Toyota Camry was equipped with 3-point lap and shoulder belts mounted in the four outboard positions. The center rear position was equipped with a lap belt. The front safety belts were both stowed within their respective retractors and were operational. Inspection of the latch plates revealed some evidence of historical use. However, there was no crash-related physical evidence identified on the webbing of either restraint. Both occupants were unrestrained at the time of the crash.

Supplemental Restraint System

The Toyota Camry was equipped with a Supplemental Restraint System that consisted of driver and front right passenger air bags. The air bags deployed as a result of the frontal crash. The driver air bag was located in the typical manner in the center hub of the steering wheel. The H-configuration module cover flaps opened as designed during the deployment and were not damaged. The flaps were symmetrical and measured 15.2 cm x 6.4 cm (6.0 in x 2.5 in), width by height. The driver air bag measured 61 cm (24 in) in its deflated state. It was tethered by four internal straps and vented by two 2.8 cm (1.1 in) diameter ports. There was no evidence of direct contact noted on the face of the air bag.

The front right passenger air bag was a mid-mount design located in the right aspect of the instrument panel. The module cover flap was rectangular in shape and was hinged on its top forward surface. The flap was constructed of 16 mm (5/8 in) thick vinyl with a sheet metal backer. The sheet metal deformed during the deployment sequence and formed the hinge. The module cover flap was contoured to the shape of the instrument panel. The overall dimensions of the flap measured 35.6 cm x 14.0 cm (14.0 in x 5.5 in), width by height. The right and center aspects of the cover flap exhibited evidence of direct contact to the child's chest. A triangular patterned red fabric transfer was identified. The transfer began 8.6 cm (3.4 in) inboard of the right edge of the flap and ended 21.1 cm (8.3 in) inboard of the right edge. The height of the pattern measured 8.4 cm (3.3 in). This contact pattern was consistent with direct contact to the child's chest and was the mechanism causing his right lung contusion. A partial interview with the child's mother at the hospital revealed the child was, in fact, wearing a red coat at the time of the crash. A second contact pattern to the flap was also identified. This contact measured approximately 3.8 cm (1.5 in) in diameter and was located 29.0 cm (11.4 in) inboard of the right edge of the flap. The center of this contact was depressed approximately 6 mm (0.25 in). This contact may have resulted from contact with the child's left hand but did not result in any injury. **Figure 7** is a view of the flap contacts.

Figure 7: View of the cover flap contacts.

The face of the deployed front right passenger air bag measured 56 cm x 51 cm (22 in x 20 in) in its deflated state. The rearward excursion of the bag measured 64 cm (25 in) from the vertical surface of the instrument panel. The bag was not tethered and was vented by two 2.0 cm (0.8 in) ports located on the side panels of the air bag. The following manufacturer's nomenclature identified the air bag: PUT12922-02E TAC060 J10076.

The deployed air bag exhibited contact evidence to its bottom, face, and top surfaces. The contact to the bottom surface of the air bag consisted of red fabric transfers consistent with the

pattern on the cover flap. The contact area measured 15.7 cm x 15.2 cm (6.2 in x 6.0 in), width by height, and began 6.4 cm (2.5 in) rearward of the instrument panel, **Figure 8**.

Figure 8: Contact to the bottom surface of the air bag.

Multiple short red fabric transfers were identified on the top surface of the bag. These transfers were not as concentrated as the bottom surface transfers and were dispersed over a large area. The extent of the contact area measured 90 cm x 26.7 cm (14 in x 10.5 in). This contact pattern began 10 cm (4 in) rearward of the instrument panel and was biased to the inboard side of the bag. Refer to **Figure 9**. The face of the air bag exhibited a brown transfer that measured approximately 18 cm x 30 cm (7 in x 12 in), width by height. This contact pattern was approximately centered on the face of the bag and is depicted within the yellow circle of **Figure 10**. This contact was not consistent with a direct contact to the child passenger and may have resulted from a possible interaction with the driver.

Figure 9: Contact evidence to the top surface of the air bag.

Figure 10: Contact evidence to the face of the air bag.

OCCUPANT DEMOGRAPHICS

	Driver	***Front Right Child Passenger***
Age/Sex	27 year old/Male	23 month old/Male
Height:	183 cm (72 in) estimated	91 cm (36 in) estimated
Weight:	77 kg (170 lb) estimated	14 kg (30 lb)
Restraint Use:	Unrestrained	Unrestrained
Usage Source	SCI inspection	SCI inspection/Occupant kinematics
Medical Treatment	None	Hospitalized

FRONT RIGHT CHILD PASSENGER INJURIES

Injury	***Injury Severity (AIS 98 update)***	***Injury Mechanism***
Right lung contusion	Serious (441406.3,1)	Deploying front right passenger air bag module cover flap
Closed head injury/traumatic brain injury, NFS	Unknown Severity (115099.7,0)	Expanding front right passenger air bag
Tongue laceration	Minor (243402.1,8)	Self inflicted

Source: Pediatric trauma center emergency room records and discharge summary.

FRONT RIGHT CHILD PASSENGER KINEMATICS

The unrestrained child was seated in the front right passenger seat in an unknown posture. Upon brake application, the child initiated a forward trajectory in response to the sudden deceleration of the vehicle. This kinematic pattern positioned the child in-close proximity to the front right air bag module at the time of the crash. Upon impact, the frontal air bags in the Toyota deployed.

The child was struck in the chest by the front right air bag module cover flap as it rotated open in an upward direction. This contact was evidenced by the red fabric transfers to the center aspect of the flap and resulted in a right lung contusion. The child's mother indicated he was wearing a red coat at the time of the crash. The contact with the flap, and the deploying air bag stopped the child's forward trajectory and displaced the child rearward. The expanding air bag also contacted the child evidenced by the aforementioned transfers during his rebound trajectory. The contact with the expanding air bag membrane did not result in further external soft injury, probably due to the rebound trajectory of the child. It was noted that the medical records specifically indicated there were no external soft tissue injuries. However, the child did sustain an unspecified closed head injury/traumatic brain injury from the force of the bag expansion. At some point during the crash sequence, the child bit his tongue evidenced by the minor laceration. The child came to rest in the vehicle's front right seat unconscious and unresponsive.

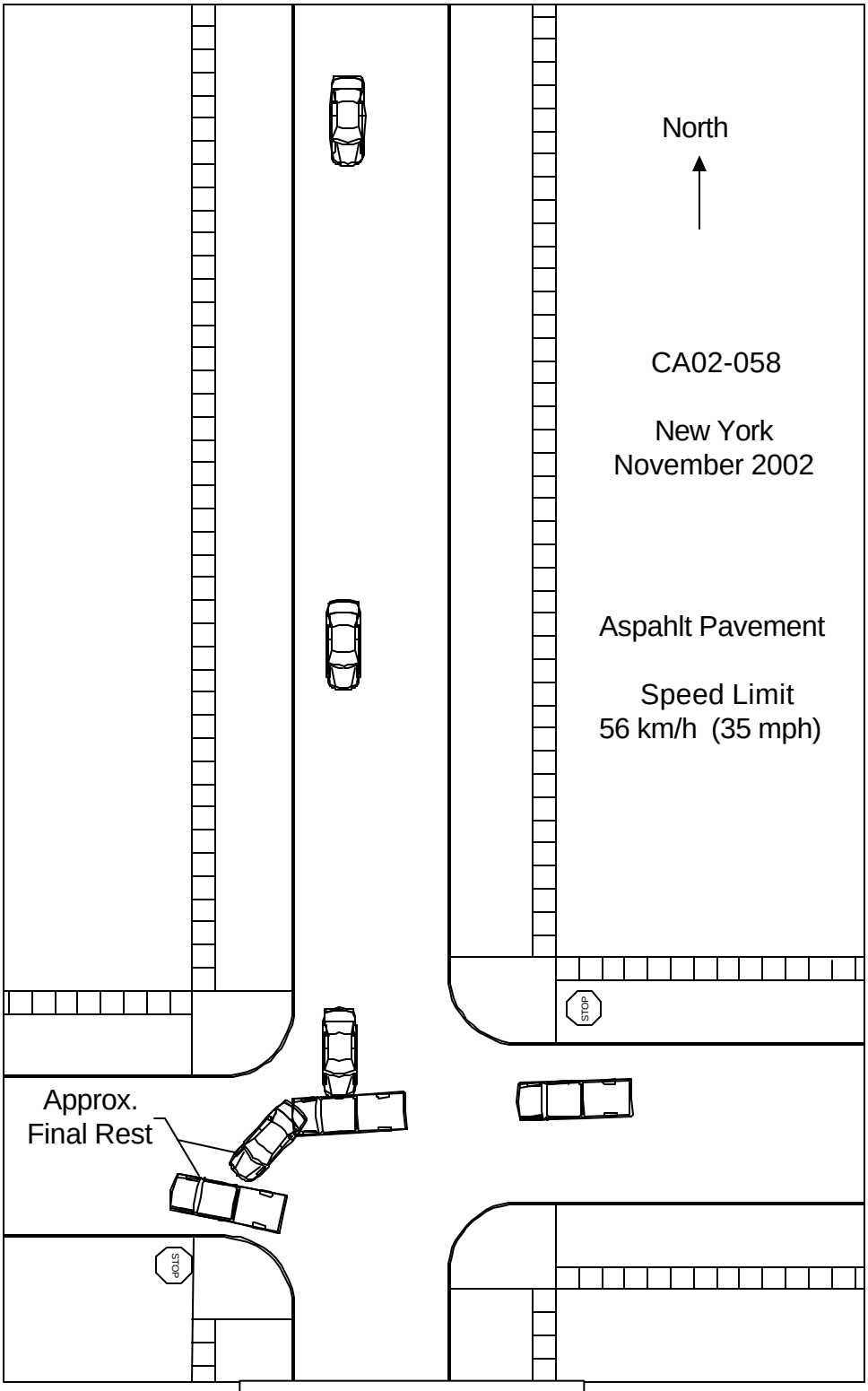

Figure 11: Crash schematic.