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**VERIDIAN REMOTE AIR BAG RELATED
ADULT DRIVER FATALITY INVESTIGATION
VERIDIAN CASE NO. CA98-071
VEHICLE: 1994 TOYOTA CAMRY
LOCATION: FLORIDA
CRASH DATE: APRIL 1998**

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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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BACKGROUND

This remote investigation focused on a single vehicle crash that resulted in a fatality to the restrained 79 year old female driver. The vehicle was a 1994 Toyota Camry that was equipped with frontal air bags for the driver and right passenger positions. The air bag system deployed as a result of an undercarriage impact sequence with a curbed median. The short stature driver was seated in a forward position (**Figure 1**) and was struck in the chest by the expanding air bag which resulted in bilateral rib fractures (2-8), a sternal fracture, a laceration of the left pulmonary artery, small focal contusions of the heart, and a 5x4 cm abrasion of the chin. She was removed from the vehicle by emergency medical technicians and transported by ambulance to a regional medical center where she expired on arrival.



Figure 1. Forward seated position of the short stature female driver.

Notification of the April 1998 crash was provided to the NHTSA by the driver's daughter. The case was subsequently assigned to the Veridian Special Crash Investigation team on December 21, 1998 and a remote investigative effort was initiated. Cooperation was established with the investigating police agency and the Regional Medical Examiner's office which provided detailed reports and photographs of the involved vehicle.

SUMMARY

Crash Site

The crash occurred in the northbound lanes of a divided state route at the junction of a designated right turn lane. The turn lane was separated from the northbound through lanes by a curbed concrete median (**Figure 2**). The investigating officer reported the height of the curbing at 15.2 cm (6.0") and the width of the median at 1.2 m (4.0'). In the vicinity of the crash site, a construction work zone was established, however, the work zone was not active during this nighttime crash. The asphalt road surface was dry and the temperature was reported at 21 degrees C (70 degrees F). The posted speed limit was 64 mph (40 mph).



Figure 2. Struck curbed median.

Vehicle Data

The involved vehicle was a 1994 Toyota Camry LE, 4-door sedan. The vehicle was identified by vehicle identification number 4T1SK12E1RU (production number deleted). The Camry was powered by a 3.0 liter, V-6 cylinder engine linked to a four-speed automatic overdrive transmission with a console mounted shifter. In addition, the Camry was equipped with power-assisted front disc/rear drum brakes and power-assisted rack-and-pinion steering. Seating was configured with front bucket seats with reclining back rests and a rear bench seat with forward folding split back rests. The four outboard seated positions were equipped with 3-point lap and shoulder belt systems. The front belt systems consisted of continuous loop webbings with a sliding latchplates and dual mode locking retractors. In addition to the manual restraint systems, a frontal air bag system provided supplemental protection to the driver and right passenger positions. The air bag system deployed as a result of the low front and undercarriage impact with the curbed median.

Crash Sequence

Pre-Crash

The driver of the Toyota Camry initiated a right turn from a movie theater complex onto the divided state route to proceed in an easterly direction. A witness in a non-contact vehicle observed the turn maneuver and followed the Camry in the easterly direction. In the vicinity of the Toyota's pre-crash travel, a construction work zone had been established, however, due to the nighttime hours, the work zone was not active and apparently did not play a role in this crash.

This witness further reported that the driver of the Camry was traveling at approximately 32-40 km/h (20-25 mph) on the outboard travel lane. This witness noted that the Camry began to drift to the right toward the designated right turn lane (**Figure 3**). She stated to

the investigating police officer that the driver of the Camry did not signal a lane change maneuver or activate the brake lights prior to impact. It should be noted that the investigating officer found an unlit cigarette broken and lightly wedged between the left sunvisor and the headliner. A cigarette lighter was also found on the left front floor pan which indicated the driver may have been attempting to light the cigarette and was distracted which resulted in the lateral drift to the right.



Figure 3. Pre-crash trajectory of the Toyota Camry.

Crash

The lower aspect of the front bumper fascia initially contacted and overrode the curbed median as evidence by abrasions to the fascia (**Figures 4 and 5**). The contact displaced the front bumper fascia in an upward direction as the vehicle continued forward, thus exposing the lower radiator support to impact the face of the curbed median. The lower radiator support was displaced rearward and vertically upward which exposed the crossmember to the face of the barrier curb. The crossmember was crushed approximately 7.6 cm (3.0") rearward from this engagement (**Figure 6**).



Figure 4. Lower front bumper fascia alignment with struck curbed median.



Figure 5. Additional view of the initial contact with the curbed median.



Figure 6. Radiator and crossmember damage from the curbed median.

The 12 o'clock impact force resulted in a sufficient longitudinal deceleration to deploy the Camry's frontal air bag system. The damage profile was out-of-scope of the WinSMASH reconstruction program, therefore the velocity change was estimated at 24-32 km/h (15-20 mph). The impact induced deceleration deployed the Camry's frontal air bag system.

Post-Crash

The vehicle came to rest with the front tires straddling the curbed median. The investigating officer documented a total damage/contact length to the curbed median of 1.1 m (3.5'). Based on the front overhang of the Camry, the vehicle's travel distance from initial contact to final rest was approximately 1.7 m (5.5').

The witness observed the crash and passed the Camry slowly on its right in the right turn lane. As she passed the vehicle, she observed the interior of the vehicle fill with a smoke-like substance that was associated with the frontal air bag deployment. In addition, the witness heard the horn sound on the Camry. She stopped her vehicle forward of the Toyota Camry and walked to the vehicle to check on the status of the driver. The doors were locked by the power-lock feature and remained locked post-crash. This witness, therefore called the emergency response number on her cellular telephone.

The first arriving officer on-scene drove past the final rest position of the Toyota and stopped near the witnesses vehicle. He asked the witness if she was injured and she responded that she was not involved in the crash. The officer walked to the Toyota Camry and observed the driver slumped to the right, resting on the front right seat cushion with both frontal air bags deployed. The officer attempted to open the doors, however, as previously noted, all doors were locked. The emergency medical technicians and local (professional) fire fighting personnel arrived on-scene. They immediately used a window punch tool to shatter the tempered left door glazing to gain access to the vehicle.

The driver was observed by the emergency personnel as restrained by the manual belt system with her

seat track adjusted to a forward position. She was immediately checked for vitals and removed from the vehicle and placed on a stretcher and transported to a regional medical center (not trauma certified) where she expired on arrival.

Vehicle Damage

Exterior

The lower aspect of the front bumper fascia of the Toyota Camry initially contacted the curbed median which abraded the fascia. The impact displaced the fascia up and rearward which exposed the lower radiator support. The radiator support impacted the curbed median as the vehicle continued forward. As a result, the lower support was displaced an estimated 15.2 cm (6.0") at the left corner area. The engine cradle/crossmember subsequently impacted the face of the curbed median which crushed the member approximately 7.6 cm (3.0") rearward. The vehicle damage is identified in **Figure 7**. The damage was rated as moderately severe with a Collision Deformation Classification (CDC) of 12-FDLW-1. During the engagement, the front right tire and wheel impacted the curbed median that resulted in minor deflection of the outer aspect of the right wheel rim. There was abrasion damage noted to the mid face of the front bumper fascia. Due to the height of this damage, it did not appear to be related to this event.



Figure 7. Profile view of the undercarriage damage deformation.

Interior

Damage to the Toyota's interior was minor and was associated with frontal air bag deployment and driver contact. There was no intrusion or deformation associated with exterior deformation. The frontal air bags deployed as designed from the respective module assemblies. The front right passenger air bag did not contact the windshield. The interior rear view mirror was displaced to the left from probable expansion of the passenger air bag.

The combination of front left air bag expansion against the driver's chest and her forward motion in response to the crash forces displaced the steering wheel forward. The upper wheel rim was deflected forward and the mounting flange was deformed as evidenced by the angular gap between the wheel and the steering column. It was unknown if the energy absorbing steering column compressed as a result of the wheel loading.

Frontal Air Bag System

The 1994 Toyota Camry was equipped with a Supplemental Restraint System (SRS) that consisted of frontal air bags for the driver and right passenger positions. In addition to the air bag modules, the SRS consisted of two front mounted crash sensors located on the upper radiator support at the forward aspects of the front fenders, and a control module that was mounted in the rear of the console. An air bag indicator lamp was mounted within the instrument cluster.

The front left (driver) air bag module was mounted within the four-spoke steering wheel rim. The steering wheel spokes were positioned at the 3/9 and 5/7 o'clock sectors. The steering wheel was equipped with a tilt mechanism that was adjusted to the mid position. The H-configuration module cover flaps were nearly symmetrical and both cover flaps opened at the designated tear points. The cover flaps were not clearly depicted in the on-scene police photographs, therefore contact evidence, if present, could not be identified. The air bag membrane was constructed of a typical nylon-type weave fabric and was tethered by internal straps. Although not visible in the police photographs, the bag was probably vented by two ports located on the back side of the bag. The peripheral seam was internally sewn. There was no damage or driver contact evidence visible to the driver bag.

The front right passenger air bag deployed from a mid mounted module in the right instrument panel (**Figure 8**). The single cover flap was formed into the top and mid aspect of the instrument panel and hinge at the upper aspect, which allowed the flap to open in an upward direction. The vinyl exterior of the cover flap was reinforced with a sheet metal liner that also acted as a hinge. Post-deployment, the cover flap was in a near vertical position.



Figure 8. Deployed front right passenger air abg.

The front right passenger air bag membrane was not tethered internally. Two vent ports were located laterally on the side surfaces of the bag at the approximate midpoint of the bag. There was no damage or driver contact evidence visible in the photographs of the passenger bag.

Manual Restraint Systems

The 1994 Toyota Camry was equipped with 3-point lap and shoulder belt systems for the four outboard seated positions and a center rear lap belt. The front belt systems consisted of continuous loop webbings with sliding latchplates that retracted onto dual mode locking retractors. The upper D-rings were adjustable, however, the position of the driver's D-ring could not be determined from the available photographs. The first responders at the crash scene unbuckled the driver's belt system which retracted into the B-pillar. Again, due to insufficient photographs, it could not be determined if there was driver induced loading evidence on the belt system, or transfers from the expanding air bag membrane.

Driver Demographics

Age/Sex:	79 year old female
Height:	157.4 cm (62.0")
Weight:	65.3 kg (144.0 lb)
Manual Restraint Usage:	3-point lap and shoulder belt system
Usage Source:	On-scene observations of the first responders
Seat Track Position:	Forward

Mode of Transport

From Scene:

Ambulance to a regional medical center (not trauma designated)

Type of Medical

Treatment:

None, expired on-arrival

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Bilateral rib fractures 2-8, originating laterally and extending anteriorly with bilateral hemothoraces and complete collapse of the left lung and partial of the right	Critical (450242.5,3)	Deploying front left driver air bag
Laceration of the left main pulmonary artery with blood in the pleural cavities and pericardial sac	Severe (421004.3,4)	Deploying front left driver air bag
Midline fracture of the sternum	Moderate (450804.2,4)	Deploying front left driver air bag
Small focal contusions over the anterior surface of the heart	Minor (441004.1,4)	Deploying front left driver air bag
5 x 4 cm superficial abrasion of the chin	Minor (290202.1,8)	Deploying front left driver air bag

* *The above injuries were documented in the autopsy report.*

Driver Kinematics

The driver of the Toyota Camry was a short stature female seated in a presumed upright driving attitude with the seat track adjusted to a forward position. She was seated on a one-piece aftermarket cushion that provided additional padding to the seat cushion and seat back surfaces. This cushion was approximately 2.5 cm (1.0") in thickness. The investigating officers measured the horizontal distances between the steering assembly and the aftermarket seat cushion. At the lower aspect (6 o'clock sector) of the steering wheel rim, a horizontal distance of 20.3 cm (8.0") was documented while a distance of 40.6 cm (16.0") was measured at the mid point of the air bag module cover (**Figure 9**).



Figure 9. Police measurement of horizontal distance between the driver air bag module and the seat back.

Observations of the first responders on-scene noted the driver was restrained by the manual 3-point lap and shoulder belt system. The driver was reported by friends as a heavy smoker and a broken cigarette was found slightly wedged between the sunvisor and the headliner with a lighter found on the left floor. It was possible the driver was attempting to light a cigarette at the time of the crash. This may have placed her slightly out-of-position in a forward direction, and in combination with her forward seated position, placed her within a close proximity to the driver air bag module at impact.

At impact with the curbed median, the frontal air bag system deployed. Due to her forward seated position, the driver was within range of the expanding front left air bag and possibly the module cover flaps. There were no photographs of the module cover flaps to support driver contact, however, the driver did not sustain soft tissue injuries commonly associated with cover flap involvement (e.g. horizontally oriented contusions and abrasions of the chest).

At deployment, the front driver air bag membrane deployed from the H-configuration module cover flaps and expanded against the chest of the forward positioned driver (**Figure 10**). She sustained bilateral rib fractures 2-8 that began at the lateral aspects and extended anteriorly with bilateral hemothoraces and a complete collapse of the left lung and a partial collapse of the right lung, a midline fracture of the sternum, a laceration of the left main pulmonary artery, and small focal contusions over the anterior surface of the heart. As the air bag membrane continued to expand, the upper aspect of the bag contacted the chin of the driver that resulted in a 5x4 cm (1.9x1.5") abrasion. There was no injury of the head or neck documented in the autopsy report.

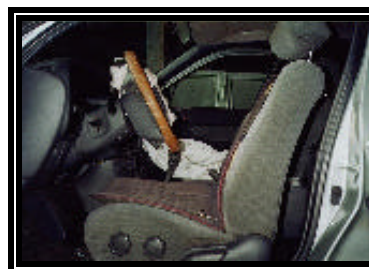


Figure 10. Forward seated position of the driver.

The driver's forward response to the 12 o'clock impact force and the subsequent bag expansion against her torso resulted in a forward deflection of the upper steering wheel rim and bending of the wheel mounting flange. This was determined by the angular gap between the hub of the wheel and the steering column. It was unknown if the energy absorbing steering column compressed as a result of the loading applied to the column.

The manual belt system restrained the driver within her seated position as she came to rest slumped to her right.

Post-Crash Activities

The witness to the crash stopped her vehicle forward of the final rest position of the Camry and exited her vehicle to check on the status of the driver. She stated the interior was filled with smoke from air bag deployment and the horn was sounding. This witness checked the doors of the vehicle and found them to be locked. She used her cellular telephone and called 911 for emergency assistance. A police officer, followed by the emergency medical technicians, were the first responders to arrive at the crash scene. They shattered the left side door windows to gain access to the vehicle and to check on the status of the driver.

Medical Treatment

The driver was removed from the Camry and transported by ambulance to a regional medical center where she expired on arrival approximately 27 minutes following the crash. The body of the driver was transported to the regional Medical Examiner's Office where an autopsy was performed. The autopsy report provided the injury documentation for this investigation.