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**VERIDIAN ON-SITE AIR BAG RELATED
CLOTHING FIRE INVESTIGATION
VERIDIAN CASE NO. CA97-014
VEHICLE: 1994 TOYOTA CAMRY
LOCATION: VIRGINIA
CRASH DATE: MARCH 1997**

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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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<p>16. <i>Abstract</i> This on-site investigation focused on the mechanism that caused a clothing fire following the deployment of the frontal air bag system in a 1994 Toyota Camry. The 56 year old female driver of the Toyota was involved in a minor front-to-rear impact sequence with a 1991 Honda Accord. The impact triggered the deployment of the Toyota's frontal air bag system. As the driver of the Toyota exited her vehicle following the crash, the driver of the Honda and a police officer noted the lower left quadrant of the Toyota's driver's jacket to be smoldering. The driver was assisted in removing the jacket and it was thrown to the ground and stepped on to extinguish the smoldering area. The driver was not injured by the burning jacket, however, she did sustain an abrasion of the left chin from her involvement with the deployed driver air bag and swelling of the left wrist from contact to the left door panel.</p>			
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BACKGROUND

This on-site investigation focused on the mechanism that caused a clothing fire following the deployment of the frontal air bag system in a 1994 Toyota Camry. The 56 year old female driver of the Toyota was involved in a minor front-to-rear impact sequence with a 1991 Honda Accord. The impact triggered the deployment of the Toyota's frontal air bag system. As the driver of the Toyota exited her vehicle following the crash, the driver of the Honda and a police officer noted the lower left quadrant of the Toyota's driver's jacket to be smoldering. The driver was assisted in removing the jacket and it was thrown to the ground and stepped on to extinguish the smoldering area. The driver was not injured by the burning jacket, however, she did sustain an abrasion of the left chin from her involvement with the deployed driver air bag and swelling of the left wrist from contact to the left door panel.

The crash was reported to the NHTSA by the investigating police department as a fire related to the air bag deployment. The crash occurred in March 1997, in Virginia. NHTSA forwarded the notification to the Veridian Special Crash Investigation Team on Tuesday, April 1, 1997 and directed the team to conduct an on-site investigation.

SUMMARY

Crash Site

The crash occurred in a right turn lane that was separated from a four-leg intersection by a curbed gore area. The turn lane transitioned the driver's travel from a six-lane divided roadway to a four-lane divided roadway. The channel was designed as a right curve which had a 3.5 percent positive slope throughout the transition from west to north travel directions. The ambient conditions were windy daylight conditions with reported sustained winds of 40-45 km/h (25-28 mph) and gusts up to 64 km/h (40 mph). The temperature was estimated at 7 degrees Celsius (45 degrees Fahrenheit).

Crash Sequence

Pre-Crash

The driver of the 1991 Honda was traveling in a westerly direction on the divided roadway on an approach to the four-leg intersection. He decelerated his vehicle and entered the designated right turn lane and stopped at the mouth of the northbound travel lane for northbound traffic flow.

The 56 year old female driver of the Toyota Camry was traveling in a westerly direction and was following the Honda Accord. The driver of the Toyota decelerated as she entered the right turn lane and momentarily focused her attention to her right, away from the roadway. As a result of her attention distraction, the driver of the Toyota failed to detect the stopped Honda Accord and did not initiate avoidance action. The Crash Schematic is attached as **Figure 11**, page 8 of this summary report.

Crash

The full frontal area of the Toyota Camry impacted the rear of the stopped Honda Accord that resulted in minor damage to the involved vehicles. The resultant directions of force were 12 o'clock for the Toyota and 6 o'clock for the struck Honda. The damage algorithm of the WinSMASH program computed velocity changes of 18 km/h (11 mph) for the Toyota and 16 km/h (10 mph) for the struck Honda Accord. Based on the minor severity damage to the vehicles, these velocity changes appear to be high, with estimated values in the 11-14 km/h (7-9 mph) range for both vehicles. As a result of the crash, the Toyota's frontal air bag system deployed.

Post-Crash

Both vehicles came to rest at or near the point of impact in the right turn lane. The driver of the Toyota was initially dazed by the crash and remained seated behind the wheel for a few seconds as the driver of the Honda exited his vehicle and walked back to the Toyota. As the driver of the Honda checked the condition of the driver of the Toyota, he observed that the Toyota driver appeared to be injured. He subsequently ran to a nearby telephone to call for help.

The driver of the Toyota exited her vehicle and surveyed the damage. A police officer, who was in the area at the time of the crash, directed her to move the vehicle to the side of the roadway in order to allow traffic to pass. She re-entered her vehicle and moved the vehicle a short distance.

During this time frame, the driver of the Honda returned to the crash site. As the driver of the Toyota exited her vehicle a second time, the Honda driver and the police officer noticed smoke coming from the front of the Toyota driver's jacket. The Honda driver stated that he saw a hole forming in her jacket which he estimated to be approximately 12.7 mm (0.5") in diameter at first sighting. His recollection was that the edge of the hole was glowing with red embers and that the hole appeared to be expanding rapidly. The Honda driver assisted the police officer in removing the jacket from Toyota driver's body. The jacket was subsequently thrown to the ground and stepped on to put out the fire.

Fire rescue personnel arrived on-scene within minutes of the crash and noted that the passenger side air bag of the Toyota was smoking. They applied water to the passenger side air bag module. Police officers who responded to the scene prior to fire rescue indicated the smoke appeared to be normal air bag deployment residue and not related to the fire condition of the driver's clothing.

The driver of the Toyota Camry sustained an abrasion of the face and left wrist pain, however, she refused medical treatment. Following the on-scene police investigation, the driver of the Toyota was transported from the scene of the crash to her residence by private vehicle. Due to the unusual nature of the clothing fire, the police authorized towing of the Toyota and impounded the vehicle for further investigation.

Vehicle Data

1994 Toyota Camry

The 1994 Toyota Camry LE was a four-door sedan that was configured as a five passenger vehicle. The

front seated positions consisted of two bucket seats with reclining seat back supports, manual track adjusters, and adjustable head restraints. The rear seat was a three-passenger bench with a split, forward folding back rest. The interior of the Toyota was covered with cloth fabric.

The front manual belt systems consisted of continuous loop webbings with sliding latch plates and dual mode locking retractors. The upper D-rings were adjustable. The driver's side was adjusted (0.75") below the full up position while the passenger side was adjusted to the full up position. The total vertical adjustment of the D-rings was 8.9 cm (3.5").

The drive train consisted of a 2.3 liter, 4-cylinder engine linked to a four-speed automatic transmission with a console mounted shifter. The brake system consisted of front disc/rear drum brakes that were power-assisted. The steering system was power-assisted rack-and-pinion with a tilt steering wheel.

The Toyota Camry was manufactured in February 1994 and was identified by vehicle identification number 4T1SK12E1RU (production number deleted). At the time of the crash, the vehicle's odometer reading was 101,138 km (62,846 miles).

The driver purchased the 1994 Toyota as a new vehicle and identified herself as the primary driver of the Camry. She noted that the vehicle was involved in a previous crash approximately one year prior to this crash. In this event with an embankment, the frontal air bag system did not deploy.

1991 Honda Accord

The 1991 Honda Accord LX was a four-door sedan that was identified by vehicle identification number 1HGCB7652MA (production number deleted). At the time of the crash, the Accord's odometer had recorded 102,807 km (63,883 miles). The interior of the Honda was configured with front bucket seats and four-point lap and shoulder belts systems. These systems consisted of motorized shoulder belts and manual lap belts. The vehicle was not equipped with air bags.

Vehicle Damage

Exterior - 1994 Toyota Camry

The Toyota Camry sustained minor frontal damage (**Figures 1 and 2**) from its impact sequence with the rear of the Honda Accord. Damage was limited to the front bumper system with displacement of the reinforcement bar. The bumper fascia rebounded to its original profile. Maximum crush was (3.25") located on the reinforcement bar 15.9 cm (6.25")



Figure 1. Front left view of the Camry.



Figure 2. Frontal damage to the Toyota Camry.

right of the vehicle's centerline. The direct contact damage began 29.2 cm (11.5") left of center and extended 99.0 cm (39.0") to the right corner of the bumper fascia. The crush profile at the bumper

reinforcement bar was as follows: C1 = 0 cm, C2 = 0.6 cm (0.25"), C3 = 5.1 cm (2.0"), C4 = 6.4 cm (2.5"), C5 = 2.5 cm (1.0"), C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact was 12-FDLW-1.

Interior - 1994 Toyota Camry

The interior of the Toyota Camry sustained minor damage that was attributed to deployment of the frontal air bag system. There was no intrusion of interior components or damage associated with exterior deformation.

The driver's left hand contacted the left door panel that was evidenced by a scuff mark to the top surface of the door, approximately 30.5 cm (12.0") rearward of the left A-pillar. The driver air bag contacted the windshield directly forward of the steering assembly. A 15.2 cm (6.0") long air bag fabric transfer was noted to the glazing, originating 26.7 cm (10.5") right of center and extending 5.1 cm (2.0") vertically.

The front right passenger air bag module cover contacted the windshield 39.4 cm (15.5") right of center and 10.2 cm (4.0") above the top of the instrument panel. The vinyl cover produced a vinyl transfer to the windshield without fracturing the laminated glazing.

Exterior - 1991 Honda Accord

The rear of the Honda Accord sustained minor damage to the bumper fascia (**Figure 3**). The direct contact damage began 41.9 cm (16.5") right of center and extended 18.1 cm (46.5") to the left corner. There was no deformation of the bumper beam or residual crush at the rear of the Honda. The CDC for this damage was 06-BDLW-1.



Figure 3. Rear damage to the Honda Accord.



Figure 4. Burn to the driver's jacket

Driver Clothing

The case vehicle's driver was wearing a medium weight, quilted, unzipped waist length brown/black pattern jacket over a long sleeve white mock turtle neck top. She was also wearing a nylon scarf which was positioned between her shirt and jacket. The jacket was manufactured of a synthetic blend while the mock turtle neck top was a polyester/cotton blend garment.

A 5.1 cm x 7.6 cm (2.0" x 3.0") burn hole was noted on the left frontal surface of the jacket in an area located 3.5 cm (1.4") left of the zipper and 26.7 cm (10.5") above the bottom edge of the jacket (**Figure 4**).

Figure 5 is a close-up view of the burn damage to the jacket. The scarf exhibited numerous burn holes (**Figure 6**) which aligned with the location of the burn hole through the jacket. The underlying white mock turtle neck top sustained a brown singe damage pattern with a raised fiber texture that was attributed to heat generation from the surface level burn of the jacket. The left frontal

surface of the jacket appeared to be discolored along the left sleeve, left shoulder, and body which may have resulted from exposure to heat.

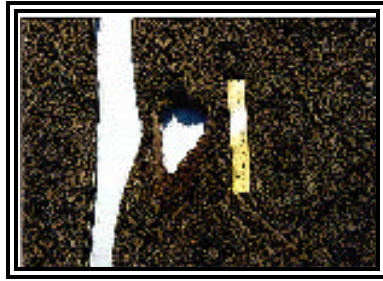


Figure 5. Close-up view of the burn to the driver's jacket.



Figure 6. Burn to the driver's scarf.

It appeared likely, however, that the driver air bag was the cause of the garment fire. This conclusion was based upon the location of the burn on the driver's jacket, the location of the driver air bag vent port with respect to the garment burn location, and the location of several areas of generant residue found to the left of the vehicle's interior. The location of the burn on the driver's clothing indicated the wheel was rotated between 190-210 degrees clockwise which was consistent with the steering maneuver through the right channel curve. In this rotated position, the upper right air bag vent port would have been aligned with the left side of the driver's jacket. It should be noted that the driver air bag did not exhibit any signs of heat singed fabric.

Another source of the surface level burn pattern may have involved debris from the front right passenger air bag. The inside of the passenger air bag contained several circular foil fragments which measured 9.5 mm (0.375") in diameter and correlated in shape and size to the gas ports in the inflator housing unit. Several of these metallic fragments were discovered on the floor in front of the driver seat. A bar coded label that was affixed to the inside surface of the passenger air bag, fragmented during the deployment sequence. Fragments of this label were found exterior to the air bag and within the bag membrane during the on-site SCI inspection of the vehicle.

Frontal Air Bag System

The 1994 Toyota Camry was equipped with a frontal air bag system that consisted of driver and passenger air bags, two front mounted crash sensors affixed to the inner aspects of the front fenders, and a console mounted air bag control module.

The driver air bag was housed within the four-spoke steering wheel rim and was concealed by H-configuration module cover flaps. Both flaps were 15.2 cm (6.0") in width at the horizontal tear seam and 6.4 cm (2.5") in height. The air bag membrane was tethered internally by four tethers affixed to a 19.7 cm (7.75") diameter reinforcement sewn to the face of the bag. In its deflated state, the bag was 71.8 cm (28.25")



Figure 7. Deployed driver air bag and the vent ports.

in diameter. The back side of the bag was vented by two 2.9 cm (1.1") diameter ports located at the 11 and 1 o'clock sectors (**Figure 7**).

The driver air bag was identified by the following identification numbers:

45165-06010
0001401
T11T13
140194
JS40A7134

The deploying driver's air bag exhausted residue to the left side of the steering column cover (**Figure 8**), located below the tilt lever mechanism. Additional residue deposits were noted on the turn signal stalk and to the left mid instrument panel below the power mirror switch.



Figure 8. Exhaust residue from the vent ports of the driver air bag.

Several beige color transfers were noted to the face of the bag that were possibly make-up transfers. The first mark was horizontally oriented located 6.4 cm (2.5") left of the tether reinforcement and extended 13.3 cm (5.25") toward the 8:30 o'clock sector. The second transfer was located 9.5 cm (3.75") above the left edge of the horizontal transfer.

The front right passenger air bag was a top mount configuration in the right aspect of the instrument panel. The single module cover flap was constructed of the vinyl outer covering with an internal sheet metal reinforcement. The flap measured 35.6 cm (14.0") in width and 17.8 cm (7.0") vertically, from the hinge point to the leading edge. The right aspect of the flap contact and scuffed the windshield at the lower right quadrant.

The passenger air bag membrane was non-tethered with two 3.8 cm (1.5") diameter vent ports located on the inboard and outboard lateral surfaces. The vent ports were located 35.6 cm (14.0") rearward of the instrument panel and 25.4 cm (10.0") below the horizontal seam line when the air bag was manually stretched rearward.

During the air bag deployment event, small metallic fragments separated from the inflator manifold ports (**Figure 9**) by design. Several of these fragments were expelled from the bag through the inboard air bag vent port (**Figure 10**). These fragments may have been embedded in the driver's clothing and initiated the surface level burning when exposed to the windy conditions. Fragments of the air bag bar code identification label attached to the passenger side air bag were noted throughout the right front seating area. Fragments were found on the left upper instrument panel adjacent to the windshield, the

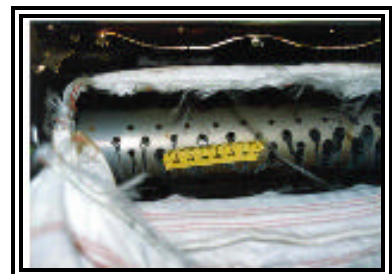


Figure 9. Inflator manifold of the front right air bag.

upper right door panel, the door latch handle, the top and outboard vertical surfaces of the right front seat cushion, and on the floor between the right front door and the right front seat. The label fragments did not exhibit any singed surfaces.



Figure 10. Fragments within the front right passenger air bag.

Driver Demographics - 1994 Toyota Camry

Age/Sex: 56 year old female
 Height: 167.6 cm (66.0")
 Weight: 59.0 kg (130.0 lb)
 Seat Track Position: Mid-to-rear
 Manual Restraint
 Usage: 3-point lap and shoulder belt system
 Usage Source: Driver interview
 Eyewear: Prescription eyeglasses
 Type of Medical
 Treatment: None, refused

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Abrasion of the left side of the chin	Minor (290202.1,2)	Deploying driver’s air bag
Pain of the left wrist	N/A, not codeable	Fling injury to the left door panel

Driver Kinematics

The driver of the Camry was seated in a normal driving posture with the seat adjusted to a mid track position. She was properly restrained by the manual 3-point lap and shoulder belt system. Immediately prior to impact, the driver looked to her right and was probably out-of-position forward at impact.

At impact, the steering wheel was rotated in a clockwise direction due to the curvature of the right turn lane. The deploying driver air bag expanded against the anterior aspect of the driver’s left arm, displacing her hand from the steering wheel rim. The arm was flung in a lateral direction by the expanding air bag resulting in a hand contact to the top surface of the left door panel. Although the driver did not sustain an injury of the hand/arm, she did complain of pain to the left wrist.

The expanding air bag subsequently contacted the left aspect of the driver’s chin. This contact sequence resulted in a soft tissue abrasion of the chin, extending partially onto left side of the face.

Following the crash, the driver exited the vehicle as the investigating officer arrived on-scene. He directed her to move her vehicle to the side of the road to restore traffic flow through the turn lane. As she exited her vehicle a second time, the officer and the driver of the struck Honda observed the surface level burning

of her clothing. They assisted her in removing the jacket from her person and stepped on the clothing article to extinguish the burning area.

The driver did not sustain injury (i.e., burns) associated with the burning clothing. At the scene of the crash, she refused medical transport and did not seek follow-up treatment.

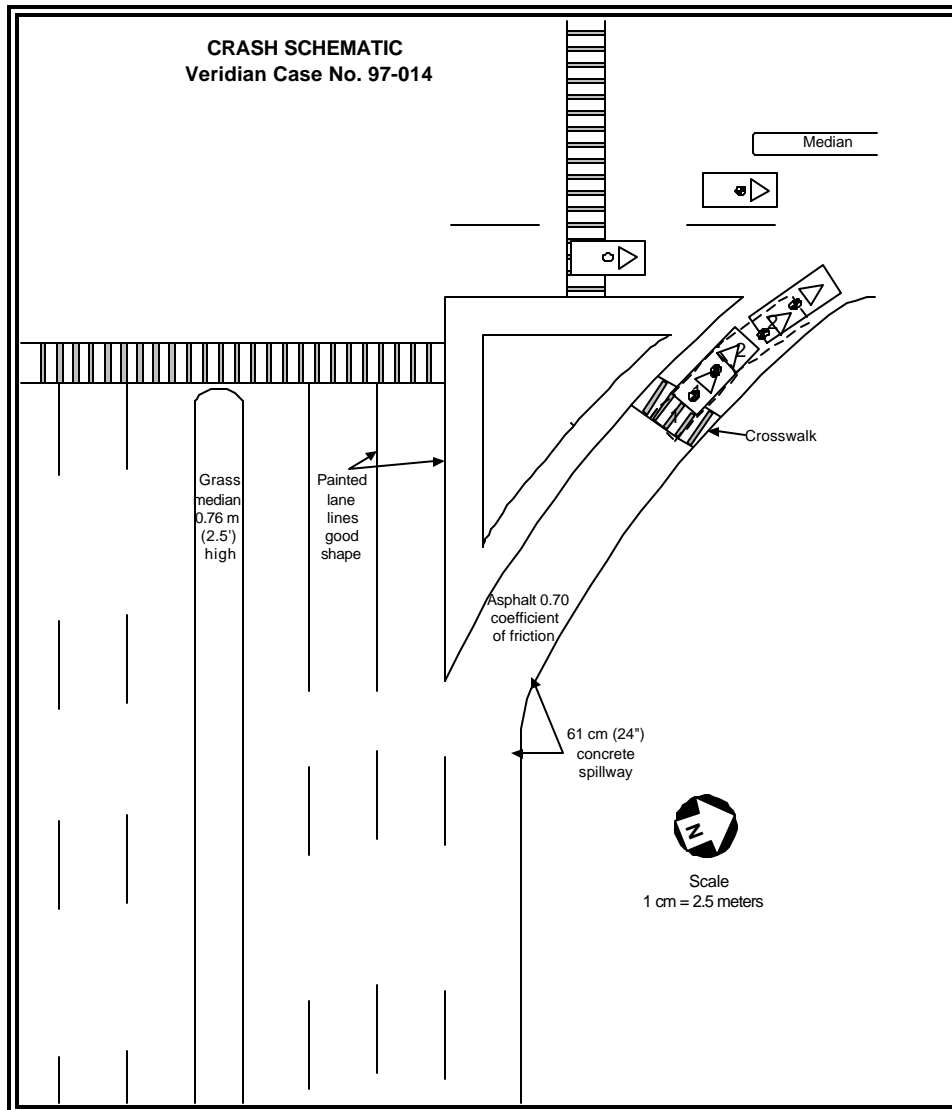


Figure 11. Crash Schematic