CRASH DATA RESEARCH CENTER

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CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH INVESTIGATION

CASE NO: CA04-026

VEHICLE: 2004 TOYOTA CAMRY

LOCATION: RHODE ISLAND

CRASH DATE: MARCH 2004

Contract No. DTNH22-01-C-17002

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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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SUBJECT VEHICLE – 2004 TOYOTA CAMRY
CRASH DATE – MARCH 2004

BACKGROUND

This on-site investigation focused on the performance of the Certified Advanced 208-Compliant (CAC) safety system in a 2004 Toyota Camry **(Figure 1)**. The manufacturer of this vehicle has certified that this 2004 Toyota Camry meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The CAC safety system included dual stage frontal air bags, front seat track positioning sensors, a front right occupant presence sensor, safety belt buckle switches and retractor pretensioners. In addition, the Toyota was equipped with seatback-mounted side impact air bags for the front positions and Inflatable Curtains (IC) for the four outboard occupant positions. The Toyota was also equipped with an air bag control module for the safety systems, which had Event Data Recording (EDR) capabilities. The air bag control module was removed from the vehicle and forwarded to NHTSA for download by Toyota. The EDR output is summarized in this Final Report. The Toyota was occupied by an unrestrained 43-year-old male driver who was involved in run-off collision with a mailbox and a utility pole. As a result of the crash, the driver's frontal air bag deployed and the driver's safety belt pretensioner fired. The driver sustained police reported scalp lacerations and leg pain and was transported by ambulance to a local hospital. The Toyota was towed from the crash site.

Figure 1. 2004 Toyota Camry.

This crash was identified from a list of claims provided by an insurance company to the National Highway Traffic Safety Administration (NHTSA) that identified Certified Advanced 208-Compliant vehicles that had been involved in crashes. NHTSA forwarded a list of vehicles to the Calspan Special Crash Investigations (SCI) team for follow-up investigation. The Toyota was located and cooperation was established with the insurance company and salvage facility to inspect the vehicle and remove the EDR for download purposes. The case was assigned to the Calspan SCI team on June 7, 2004 as an on-site investigative effort. The Toyota was inspected on June 17, 2004.

SUMMARY

Crash Site

This run-off-road crash occurred during the nighttime hours of March 2004. At the time of the crash, the weather was clear with no adverse conditions. The crash occurred off the left road side of a two-lane east/west roadway **(Figure 2)**. The roadway curved to the

right for westbound traffic and terminated at the point of the left side road departure. The roadway had a negative grade to the west that averaged a measured 8 percent along the vehicle's pre-crash trajectory. The roadway was surfaced with asphalt that was in worn condition without defects. There were no markings on the road surface. The travel lanes were bordered by shallow earth embankments that consisted of grass and trees. In the vicinity of the crash site, the immediate left roadside contained a mailbox, a guy wire, and a wooden utility pole. The posted speed limit for the east/westbound traffic was 48 km/h (30 mph). The scene schematic is included as **(Figure 12)** of this report.

Figure 2. Westbound view of crash site.

Vehicle Data – 2004 Toyota Camry

The 2004 Toyota Camry was manufactured on 12/03 and was identified by the Vehicle Identification Number (VIN): 4T1BE30K64U (production sequence omitted). The odometer reading at the time of the inspection was unknown due to the lack of 12 volt power to the vehicle. The Camry was a four-door sedan that was equipped with a 2.4-liter, four-cylinder engine linked to a 4-speed automatic transmission with front-wheel drive. The service brakes were power-assisted four-wheel disc with anti-lock (ABS) and electronic brake-force distribution. The Camry was equipped with OEM steel wheel rims with plastic wheel covers and P215/60R16 Michelin MXV4 all-season tires. The manufacturer recommended tire pressure was 200 kPa (29 PSI). The specific tire data at the time of the SCI inspection was as follows:

Position	Measure Pressure	Measure Tread Depth	Damage
Left Front	0 kPa	7 mm (9/32)	Tire debeaded, wheel rim beads deformed by impact
Left Rear	245 kPa (35.5 PSI)	7 mm (9/32")	None
Right Front	241 kPa (35 PSI)	7 mm (9/32")	None
Right Rear	241 kPa (35 PSI)	7 mm (9/32")	None

The interior of the Toyota consisted of front buckets seats with height adjustable head restraints and a three-passenger split bench seat (60/40) and height adjustable head restraints for the outboard seating positions. The driver's head restraint was adjusted to the full-up position and the front right was adjusted to the full-down at the time of the vehicle inspection. The second row head restraints were adjusted between the mid-to full-up positions.

Crash Sequence

Pre-Crash

The restrained 43-year-old male driver of the 2004 Toyota Camry was operating the vehicle westbound on the two-lane roadway negotiating the right curve with a negative grade **(Figure 3)**. As the driver continued westbound, he allowed the vehicle to drift left across the eastbound travel lane as he exited the curve. The Camry departed the south (left) road edge in a presumed tracking mode. Due to the duration between the crash date and the SCI investigation, there was no physical evidence to support the vehicle's trajectory.

Figure 3. Toyota's westbound approach.

Crash

The Toyota impacted a mailbox post with the front left corner area **(Figure 4)**. The mailbox separated from the post and subsequently impacted the lower left A-pillar as the Camry continued forward. Minor damage resulted to the pillar. The Toyota continued approximately 9 meters (30 feet) forward and impacted and fractured a wooden utility pole **(Figure 5)** with the front left corner area, masking the initial impact damage from the mailbox. This event resulted in a 12 o'clock impact force. Although the corner impact was outside the scope of the WINSMASH program, the Barrier Equivalent algorithm was used to calculate an approximate delta V due to the pole yielding at impact. Two crush profiles were documented for this impact, one at bumper beam level and the second at the upper radiator support. The average of the two profiles was used to calculate a total delta V of 19 km/h (11.2 mph) with a longitudinal component of -19 km/h (11.8 mph) and lateral component of 0 km/h (0 mph). The pocketing of the pole into the fender and the tire/wheel and suspension could not be accounted for in this reconstruction, therefore the output is conservative. The vehicle's onboard EDR recorded a longitudinal velocity change of 62 km/h (38.5 mph) at 150 ms of Algorithm Enable (AE). As a result of the frontal impact, the driver's frontal air bag deployed at an EDR reported High (Stage 2) level. The driver's safety belt retractor pretensioner fired. The seatback-mounted side air bags and the IC's did not deploy.

As a result of the offset left impact, the Toyota rotated approximately 30 degrees counterclockwise to final rest. At rest, the Toyota remained engaged against the fractured pole, straddling the south road edge. In this position, the vehicle was partially blocking the eastbound travel lane.

Post-Crash

The driver sustained police reported scalp lacerations and an unspecified leg injury. He was removed from the vehicle by rescue personnel and transported to a local hospital for treatment. The Toyota sustained disabling damage and was towed from the crash site and subsequently assessed a total loss by the insurance company.

Figure 4. Area of struck mailbox.

Figure 5. Area of struck utility pole. (Utility pole was replaced.)

Vehicle Damage

Exterior Damage

The Toyota impacted the mailbox post and the utility pole with the front left corner area. The initial impact with the mailbox was masked by the subsequent pole engagement. The Collision Deformation Classification (CDC) for this impact was estimated at 12-FLEN-1. The mailbox impacted the lower aspect of the left A-pillar and corner of the windshield as the vehicle continued forward. The damage consisted of deformation with laterally oriented abrasions to the upper left A-pillar. The mailbox also fractured the lower left corner of the windshield and the left side view mirror **(Figure 6)**. The CDC for this impact was 12-FLGE-6.

Figure 6. Damage from the mailbox impact.

The Toyota sustained moderate severity damage as a result of the impact with the utility pole **(Figure 7)**. The damage involved the bumper fascia, bumper support, hood, left front fender, left front tire/wheel and suspension, and the upper radiator support. The engagement with the pole crushed the left corner of the bumper beam to a maximum depth of 19 cm (7.5”) and the left corner of the upper radiator support 43 cm (16.9”). The direct damage contact began 43 cm (17”) left of the centerline and extended 27 cm (10.8”) to the left bumper corner. Two crush profiles were used to document the residual crush. Six equidistant crush measurements were used to document the crush using a combined direct and induced damage length of 121 cm (47.5”). The crush profile documented at the bumper level was as follows: C1 = 19 cm (7.5”), C2 = 9 cm (3.5”), C3 = 8 cm (3.1”), C4 = 6 cm (2.4”), C5 = 6 cm (2.4”), C6 = 2 cm (0.8”).

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The crush profile documented at the upper radiator support was as follows: C1 = 43 cm (16.9”), C2 = 4 cm (1.6”), C3 = 1 cm (0.4”), C4 = 0 cm, C5 = 0 cm, C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact was 12-FLEE-3.

The average of these two profiles was used for the damage algorithm of the WINSMASH program to calculate a delta V. The average crush measurements for this input were as follows: C1 = 31 cm (12.2”), C2 = 9 cm (3.5”), C3 = 8 cm (3.1”), C4 = 6 cm (2.4”), C5 = 6 cm (2.4”), C6 = 1 cm (0.4”). **Figure 8** is a lateral view of the two profiles.

Figure 7. Front left corner damage from the utility pole impact.

Figure 8. Lateral view depicting the extent of frontal crush.

Interior Damage

The interior of the 2004 Toyota Camry sustained moderate severity damage as a result of occupant contacts. There was no intrusion of the passenger compartment. At impact with the utility pole, the driver’s frontal air bag deployed. The unrestrained driver initiated a forward trajectory and contacted the knee bolster, which deformed the plastic knee bolster panel. The driver’s torso loaded through the deployed air bag and engaged the steering wheel rim, deforming the lower right quadrant of the steering wheel 3 cm (1”) forward. His loading force was transmitted into the steering column which fully compressed, disengaging the column from the instrument panel substructure. This column was not equipped with typical shear capsule brackets, therefore no measurements were obtained. Also noted were hair and glass fragments in a 6 cm (2.5”) diameter area at the forward edge of the sunroof cover from rebound contact from the driver’s head. A tissue/fabric transfer was noted to the rear aspect of the transmission lever from contact with the driver’s right hand. An oily scuffmark was located 27-35 cm (10.5-13.8”) right of center and 19-22 cm (7.5-8.5”) below the top apex of the instrument panel from contact with the driver’s head. Body fluid was located on the center instrument panel 14-15 cm (5.5-6.5”) right of center and 22-24 cm (8.5-9.5”) below the top IP from possible contact with driver’s right hand post-crash. **Figure 9** is an overall view of the driver’s contact points.

Figure 9. Overall view of the driver's trajectory and contact points.

Certified Advanced 208-Compliant Safety System

The 2004 Toyota Camry was equipped with a Certified Advanced 208-Compliant (CAC) frontal safety system. The manufacturer of this vehicle has certified that this 2004 Toyota Camry meets the advanced air bag requirements for Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The system consisted of dual stage frontal air bags, front seat track positioning sensors, a front right occupant presence sensor, safety belt buckle switches, and front safety belt retractor pretensioners. The system also consisted of a passenger air bag indicator lamp **(Figure 10)** which notified the occupants of the on/off status of the front right air bag. An air bag control module monitored the system for faults and measured and predicted crash severity, while monitoring seat track position, belt status, and occupant presence in order to deploy the appropriate safety systems. The air bag control module had Event Data Recording (EDR) capabilities. The air bag control module was removed from the Toyota and forwarded to NHTSA for download by Toyota. The EDR output is included in the section that follows.

Figure 10. Passenger air bag indicator light for CAC safety system.

Figure 11. Deployed driver's frontal air bag.

The driver's frontal air bag deployed during the impact sequence with the utility pole. The driver's air bag was located in the center of the steering wheel hub **(Figure 11)** and was concealed by two H-configuration module cover flaps. The top flap measured 12 cm (4.6") in width at the top hinge point and 17 cm (6.5") in width at the horizontal tear seam. The upper flap was 10 cm (4") in height. The lower cover flap measured 14 cm (5.4") in width and 8 cm (3") in height. The air bag membrane measured 59 cm (23") in diameter in its deflated state. No occupant contact evidence was present on the air bag. The air bag was vented by two 3 cm (1") diameter ports that were centered 8 cm (3.3") forward of the peripheral seam at the top aspect of the air bag. The bag was tethered by two 12 cm (4.8") wide band tethers that were sewn to the face of the air bag at the 3 and 9 o'clock positions. A 22 cm (8.8") diameter tether stitch pattern was located on the center face of the air bag.

The driver's bag was identified by the following nomenclature that was stamped on the top surface of the air bag membrane:

GA120-05520
055231126914

The front right passenger air bag was a top-mount design incorporated into the right instrument panel. The front right seating position was not occupied during the crash, therefore the air bag control module did not warrant the deployment of the front right air bag.

Event Data Recorder

The 2004 Toyota Camry was equipped with an air bag control module that had Event Data Recording (EDR) capabilities. The insurance adjuster approved the removal of the air bag control module from the Toyota by the Calspan SCI team for download by Toyota. The module was forwarded to NHTSA and shipped to Toyota for remote download. The output data provided to the SCI team and is summarized as follows:

- The driver's safety belt system was recorded as Unbuckled
- The front right occupant detection was reported as No Level (unoccupied)
- The driver's seat track position was recorded as Rearward
- Two previous events were recorded
- Previous event was recorded at 600 ms of Algorithm Enable (AE)
- The driver's air bag deployed at a High Level (Stage 2)
- Deployment time was 22 ms of AE
- The front right passenger air bag was "Not Fired"
- The maximum recorded delta V was 62 km/h (38.5 mph) at 150 ms of AE

Inflatable Side Impact Protection Systems

The 2004 Toyota Camry was equipped with front seatback-mounted side impact air bags and Inflatable Curtain (IC) air bags for the four outboard seating positions. The IC's were located in the roof side rails. The Toyota did not sustain a side impact, therefore the side impact air bag systems did not deploy in this crash.

Manual Restraint Systems

The 2004 Toyota Camry was equipped with manual 3-point lap and shoulder safety belts for the five designated seated positions. The driver safety belt system was configured with a sliding latch plate, Emergency Locking Retractor (ELR), height adjustable D-ring, and a retractor pretensioner with force limiters. The adjustable D-ring was in the full-down position at the time of the SCI inspection. The driver did not use the safety belt in the crash, which was evidenced by the occupant contact points to the frontal components and the fired status of the retractor pretensioner. The pretensioner spooled the continuous loop webbing taut against the B-pillar **(Figure 12)**.

Figure 12. Stowed and taut position of the driver's safety belt webbing due to the fired

The front right safety belt was configured with a sliding latch plate, switchable ELR/Automatic Locking Retractor (ALR), height adjustable D-ring, and a retractor pretensioner with force limiters. The front right D-ring was in the full-down position at

the time of the SCI inspection. The front right seat was not occupied, therefore the pretensioner did not deploy in this crash.

The rear safety belts were configured with sliding latch plates and switchable ELR/ALR retractors.

Driver Demographics/Data

Age/Sex:	43-year-old/ Male
Height:	Not available
Weight:	Not available
Seat Track Position:	Full-rear [24 cm (9.4”) of track travel]
Manual Restraint Use:	None Used
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Egress from Vehicle:	Removed by rescue personnel
Mode of Transport From Scene:	Ambulance
Type of Medical Treatment:	Transported to a local hospital, admission status was unknown

Driver Injuries

Injury	Injury Severity (AIS90/Update 98)	Injury Source
Scalp lacerations, NFS	Minor (190600.1,9)	Windshield
Leg injury, NFS	Unknown	Knee bolster

Source – Police Accident Report

Driver Kinematics

The 43-year-old male driver of the 2004 Toyota Camry was seated in a presumed upright posture and was not restrained by the manual 3-point lap and shoulder safety belt. The lack of safety belt usage was determined by the driver contact points with frontal components as well as the locked and taut position of the belt system against the B-pillar from the fired retractor pretensioner. The driver’s seat was adjusted to a full-rear track position and the head restraint was adjusted to the full-up position. In this position, the horizontal distance between the center of the driver’s air bag module and the seat back was 58 cm (23”), measured 36 cm (14”) above the seat bight. The driver’s seat back angle was 21 degrees.

The Toyota departed the left road side and impacted the mailbox with the front left corner area. This impact was minor in severity and did not significantly displace the driver from his pre-impact position. At impact with the utility pole, the driver’s frontal air bag deployed. The driver initiated a forward trajectory and loaded through the deployed air bag with his torso. This loading force deformed the lower steering wheel rim and compressed the energy absorbing steering column. As he compressed the air bag and the steering assembly, his head jackknifed forward and struck the windshield which resulted in scalp lacerations. His knees contacted and deformed the plastic knee bolster panel.

The driver's right hand contacted the rear aspect of the transmission lever which was evidenced by a tissue transfer. The driver's head contacted the sunroof cover on a probable rebound contact. This is supported by hair and glass fragments to the sunroof cover that were located 34-41 cm (13.5-16") aft of the windshield header. The driver slumped to his right and contacted the right lower instrument panel with his head. He came to rest with his head and upper torso resting on the front right seat cushion. Blood was noted at the front right safety belt buckle/seat cushion juncture. The Stage 2 deployment of the driver's frontal air bag provided the driver with a ride down of the crash forces which prevented him from direct contact with the steering assembly and potentially serious thoracic injury.

The driver sustained police reported scalp lacerations and an unspecified leg injury. He was transported to a local hospital by ambulance; however, the hospital in which he was taken was not specified and the driver failed to respond to telephone messages. Therefore, the driver's medical records were not obtained.

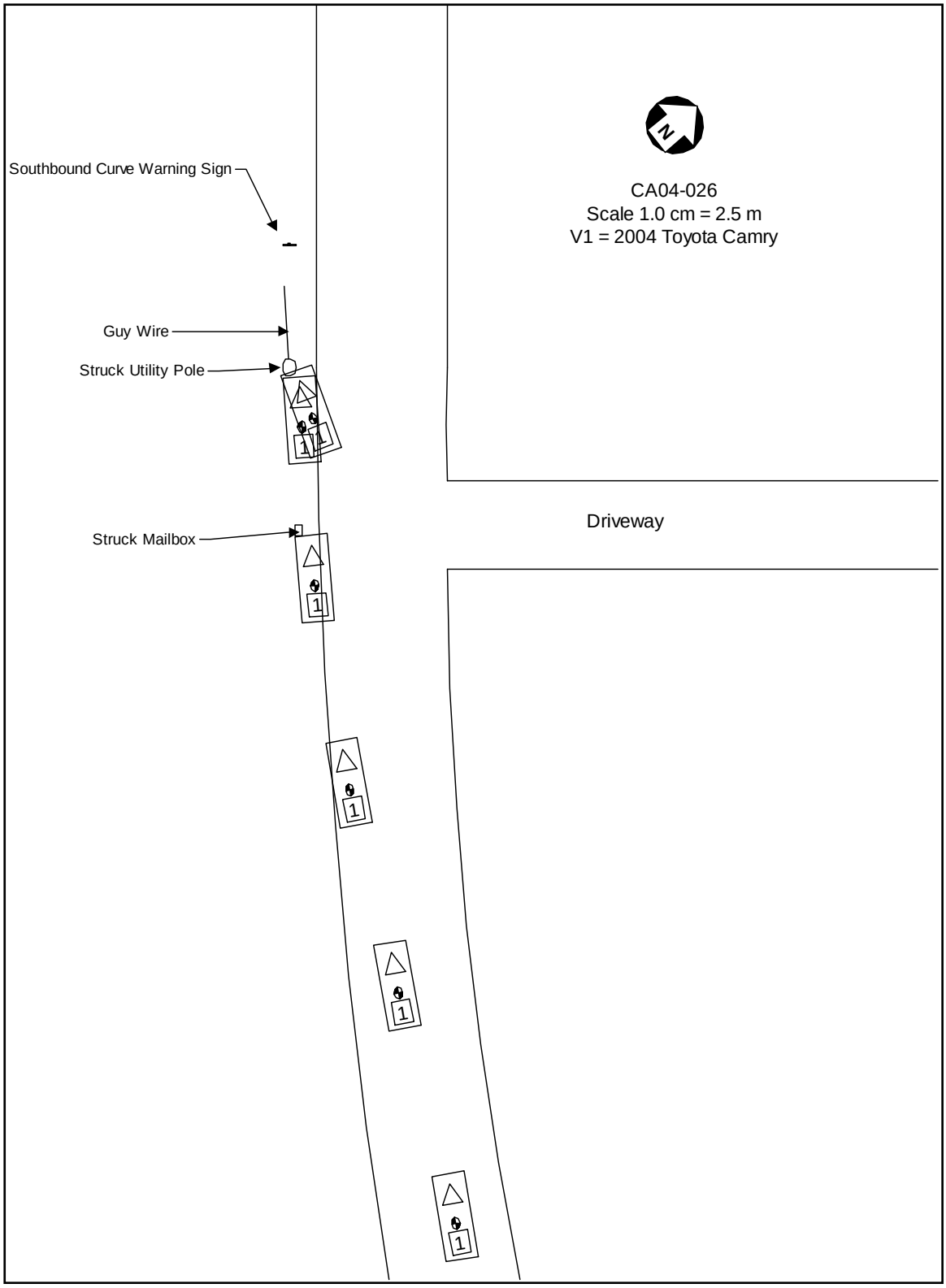

Figure 12 - Scene Schematic