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CALSPAN ON-SITE SIDE IMPACT INFLATABLE OCCUPANT PROTECTION SYSTEM CRASH INVESTIGATION

SCI CASE NO.: CA11006

VEHICLE: 2010 TOYOTA COROLLA S

LOCATION: NORTH CAROLINA

CRASH DATE: NOVEMBER 2010

Contract No. DTNH22-07-C-00043

Prepared for:

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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 on-site investigation focused on the side impact inflatable occupant protection system of a 2010 Toyota Corolla S sedan **(Figure 1)** which was involved in a side impact crash. The Toyota was impacted on the left plane by the front plane of a 1985 Ford F-250 pickup truck. This crash was identified by the Calspan Special Crash Investigations (SCI) team through an online inventory search of a regional vehicle salvage facility on March 8, 2011. Based on the location of the impact and the severity of the damage, this case was assigned by the Crash Investigation Division (CID) of the National Highway Traffic Safety Administration (NHTSA) for investigation on March 16, 2011. The on-site portion of the investigation was initiated on March 17, 2011 and involved the inspection and documentation of the Toyota and the crash scene, a detailed interview with the driver of the vehicle, and an interview with a resident near the crash site. Additionally, the Event Data Recorder (EDR) of the Toyota was imaged during the SCI inspection of the vehicle.

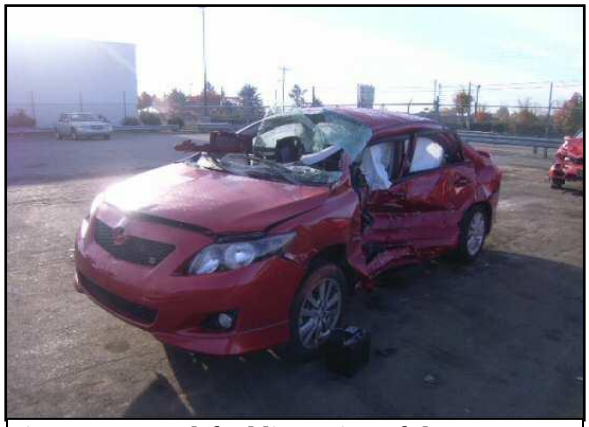

Figure 1: Front left oblique view of the 2010 Toyota Corolla.

The 29-year-old restrained male driver of the Toyota was operating the vehicle eastbound approaching a four-leg intersection. The Toyota was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system, side impact air bags mounted in the front seat backs, and combination roll-sensing/side impact Inflatable Curtain (IC) air bags. The driver of the 1985 Ford F-250 was operating her vehicle southbound approaching the same intersection. Both vehicles entered the intersection, with the Toyota attempting to turn left across the path of the Ford. The front of the Ford impacted the left side of the Toyota. The Toyota's driver air bag, driver seat-mounted side impact air bag, and both IC air bags deployed in the crash. The force of the impact redirected the Toyota in a southeast trajectory into a landscape center median. The back plane of the Toyota impacted a wood post and irrigation control box, and the vehicle then came to rest. The Toyota driver sustained serious injuries and was transported to a regional trauma center where he was admitted for 16 days.

CRASH SUMMARY

Crash Site

This crash occurred during the morning hours of November 2010. The environmental conditions at the time were daylight, dry, and cloudy. The crash occurred at the four-leg intersection of a two-lane divided, east/west residential roadway and a three-lane divided, north/south main roadway. Traffic volume was reported by a local resident to be very high during the weekday morning time of the crash. Further, this resident reported that it was difficult to turn left from the residential roadway onto the main roadway from either direction due to this traffic volume.

The bituminous residential roadway that the Toyota was traveling on extended east/west and was straight. It had a level grade in the pre-crash area that transitioned to a negative 2 percent grade as it approached the intersection. The eastbound travel lanes measured 8 m (26.2 ft) in width and were separated into two lanes by a faint painted line as it neared the intersection. The center median measured 4.9 m (16.1 ft) in width and ended 13.1 m (43 ft) west of the intersection. The eastbound approach to the intersection was controlled by a stop sign. An eastbound trajectory view of the Toyota's travel path is depicted in **Figure 2**.

The bituminous main roadway on which the Ford was traveling extended north/south, had a negative 1 percent grade, and followed a shallow left curve. The radius of curvature measured 410 m (1345 ft). In the southbound direction of travel, the right lane was 4.1 m (13.5 ft) in width, the center lane was 3.7 m (12.1 ft) in width, and the designated left turn lane approaching the intersection was 4 m (13.1 ft) in width. The median was landscaped with trees and bushes and measured 5.7 m (18.7 ft) in width. **Figure 3** depicts the southbound approach of the Ford to the intersection. A Scene Diagram is included at the end of this report.

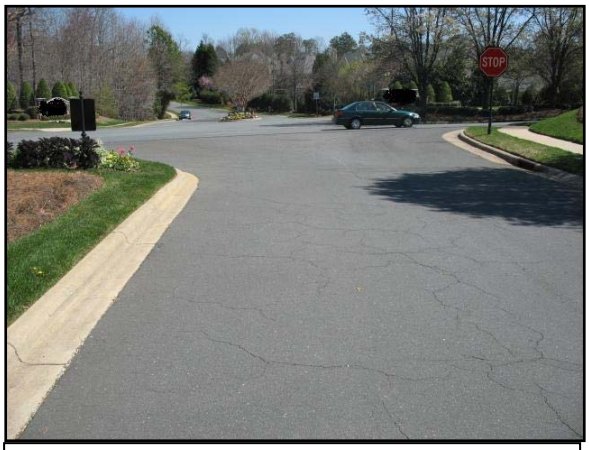

Figure 2: Eastbound trajectory view of the Toyota on the approach to the intersection.

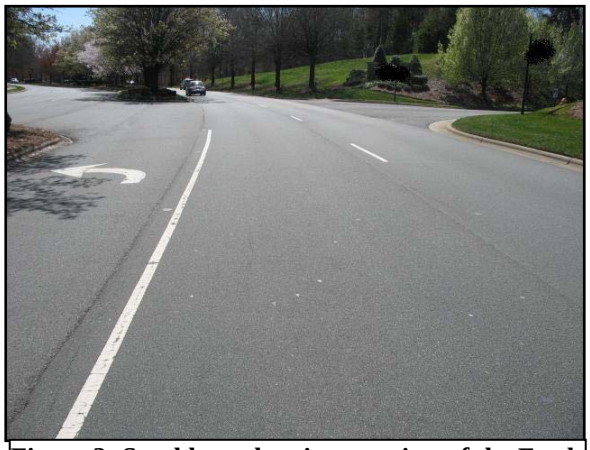

Figure 3: Southbound trajectory view of the Ford on the approach to the intersection.

Pre-Crash

The driver of the Toyota was operating the vehicle eastbound towards the intersection at an EDR reported speed of 23.9 km/h (14.9 mph) approximately 4.3 seconds prior to Algorithm Enable (AE). Based on the imaged Toyota EDR data, the driver of the Toyota applied the brakes and decelerated to a speed of 8 km/h (5 mph) approximately 2.3 seconds prior to AE, and then accelerated to a speed of 22 km/h (13.7 mph) at AE. The driver of the Ford was operating her vehicle southbound towards the same intersection in the center lane of the three-lane roadway at a police-reported speed of 64.4 km/h (40 mph). The Toyota entered the intersection with the intent of completing a turn left, subsequently crossing the travel path of the Ford. The driver of the Toyota stated in the interview that he looked, but did not see the Ford prior to entering the intersection. Accordingly, he did not initiate any avoidance maneuvers prior to the initial impact. Coincident to the Toyota, the Ford maintained its trajectory on approach to the intersection. There was no evidence at the scene of any pre-crash avoidance action by the Ford.

Crash

The front plane of the Ford impacted the left plane of the Toyota (Event 1) within the intersection **(Figure 4)**. The vehicle-to-vehicle impact began slightly forward of the Toyota's left front axle, reaching maximum engagement at the passenger compartment area of the Toyota. The direction of force was within the 10 o'clock sector for the Toyota and the 12 o'clock sector for the Ford. The force of the impact actuated the Toyota's front left retractor pretensioner and deployed the driver's frontal air bag, the driver's seat-mounted side impact air bag, and both IC air bags.

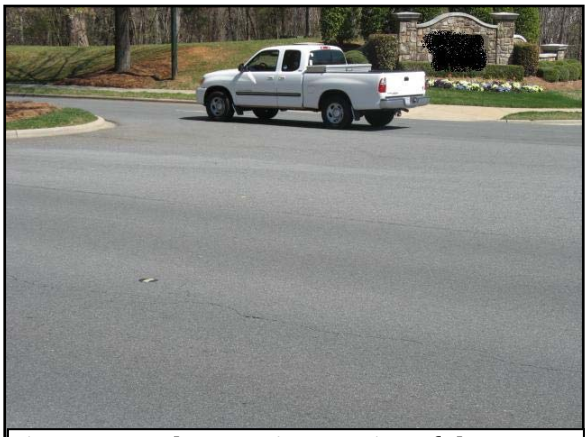

Figure 4: Northeast trajectory view of the Toyota at the Event 1 point of impact (POI).

The force of the impact redirected the Toyota into a right side-leading southeast trajectory within the intersection. As the vehicles separated from their initial engagement, the Toyota also initiated a counterclockwise (CCW) rotation. The Toyota traveled 12.3 m (40.4 ft) southeast towards the median of the north/south roadway as it rotated 70 degrees CCW. The Toyota traveled over the 16 cm (6 in) barrier curb that bordered the landscape median to the south of the intersection. The back plane of the

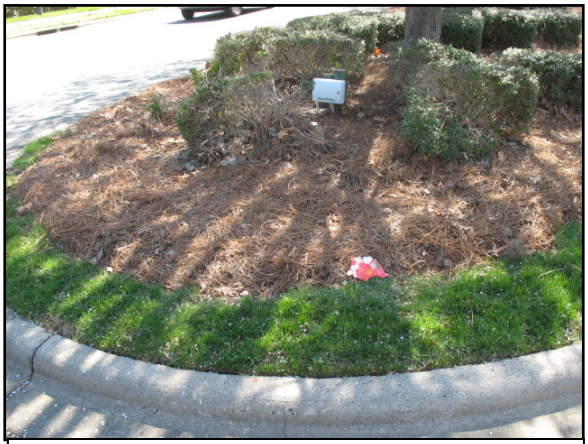

Figure 5: Event 2 POI (Irrigation control) and final rest location of the Toyota. Southward view of the south median.

Toyota then impacted a 10 cm (4 in) wood post that elevated a plastic irrigation control box (Event 2). The wood post was sheared off by the engagement, and the Toyota continued south for another 60 cm (23.6 in). The Toyota came to rest on the landscape median facing north. **Figure 5** depicts the Event 2 Point of Impact (POI) and the final rest position of the Toyota. The Ford was redirected 20 degrees to its left by the initial impact and traveled 13.2 m (43.3 ft) southeast before coming to rest with its front wheels against the curb line of the south median facing southeast.

Post-Crash

Police, emergency medical, and fire personnel responded to the crash site. The driver of the Toyota was conscious, but was removed from the vehicle due to perceived injuries. Emergency personnel removed the windshield and used hydraulic rescue tools to remove the right front door of the Toyota to extricate the driver. Both drivers were transported by ground ambulance to a regional trauma center for treatment. The Toyota and the Ford were towed from the scene due to disabling damage and transferred to a regional salvage facility, where the Toyota was inspected. The Ford was sold by the salvage facility prior to SCI's initiation of this case.

2010 TOYOTA COROLLA S

Description

The 2010 Toyota Corolla was identified by the Vehicle Identification Number (VIN) 2T1BU4EE7ACxxxxxx. The date of manufacture is unknown. The vehicle had been purchased new by the driver and his wife two months prior to this crash. The odometer reading was 6,806 km (4,229 mi) at the time of the SCI inspection. The front-wheel drive Toyota was powered by a 1.8-liter inline four-cylinder engine linked to a four-speed automatic transmission. The braking system consisted of power-assisted front disc and rear drum brakes with four-wheel antilock, electronic brakeforce distribution, and brake assist. The Toyota was also equipped with Electronic Stability Control (ESC), traction control, and a direct Tire Pressure Monitoring System (TPMS). The driver stated in the interview that there were no illuminated warning lights for the TPMS, check engine, or maintenance reminder prior to the crash. The Toyota was equipped with four Goodyear Eagle RS-A tires in size P205/55R16, which matched the vehicle manufacturer's recommendation. The vehicle manufacturer's recommended cold tire pressure was 234 kPa (34 PSI) for the front and rear. Specific tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	200 kPa (29 PSI)	7 mm (9/32 in)	No	None
LR	200 kPa (29 PSI)	8 mm (10/32 in)	No	None
RR	186 kPa (27 PSI)	8 mm (10/32 in)	No	None
RF	Tire flat	7 mm (9/32 in)	No	De-beaded

The interior of the Toyota was configured with cloth-surfaced seating for five-passengers (2/3). The front bucket seats were separated by a center console. The driver's seat was damaged by passenger compartment intrusion. The seat track was adjusted 4 cm (1.6 in) forward of full-rear and inoperable at the time of the SCI inspection. The driver's seat back was also deformed to a 29 degree angle aft of vertical. The front right seat was not damaged in this crash, and its operational seat track was in the full-rear position with the seat back slightly reclined to a 23 degree angle aft of vertical. The second row consisted of a bench with split 60/40 folding backs. The rear left seat was compressed 12 cm (4.7 in) by the lateral intrusion of the left rear door. All seating positions were equipped with height adjustable head restraints. The driver's head restraint was not damaged, but was removed by EMS during extrication of the driver. The front right, rear center and rear right head restraints were in the full-down position at the time of the SCI inspection. The rear left head restraint was 3 cm (1 in) above the full-down position in order to accommodate for the installation of a forward facing Child Restraint System (CRS) in the rear left seating position. The CRS was not occupied during this crash.

The interior occupant manual restraint systems consisted of 3-point continuous loop lap and shoulder safety belts for all five designated seating positions. The vehicle was also equipped with front seat safety belt retractor pretensioners, dual stage CAC frontal air bags, front seat-mounted side impact air bags, and roof side rail-mounted combination roll-sensing/side impact IC air bags which provided protection for the four outboard seating positions.

Exterior Damage

Figure 6: Event 1 impact damage to the left side of the Toyota.

The left plane of the Toyota sustained moderate damage in the Event 1 impact **(Figure 6)**. The direct contact damage began 41 cm (16.1 in) forward of the left front axle and extended rearward 303 cm (120 in). The combined direct and induced damage (Field L) began 41 cm (16.1 in) forward of the left front axle and extended rearward 323 cm (127.2 in). A residual crush profile was measured at the mid door level and was as follows: C1 = 0 cm, C2 = 19 cm (7.5 in), C3 = 44 cm (17.3 in), C4 = 45 cm (17.7 in), C5 = 5 cm (2 in), C6 = 0 cm. The maximum crush measured 54 cm (21.3 in) and was located on the left front door, 117 cm (46 in) aft of the left front axle. At that location, the Door Sill Differential (DSD) measured 34 cm (13.4 in). The height of the maximum crush was 57 cm (22.4 in). The sill height of the Toyota was 32 cm (12.6 in). The Missing Vehicle Algorithm of the WinSMASH program was used to calculate the severity of the crash (delta-V). The total delta-V for the Toyota was 48 km/h (29.8 mph), with longitudinal and lateral components of -24 km/h (-14.9 mph) and 42 km/h (26.1 mph), respectively. For comparison purposes, the maximum EDR-reported frontal delta-V was 24.1 km/h (15.0 mph) and the maximum EDR-

reported lateral delta-V was 32.8 km/h (20.4 mph). The left doors of the Toyota deformed and intruded into the passenger compartment. Both left side doors were jammed shut post crash. The left wheelbase was shortened by 3 cm (1.2 in). The windshield was fractured, and all left side glazing and backlight were disintegrated by impact forces. The right front glazing was removed by emergency personnel during extrication. The Collision Deformation Classification (CDC) for Event 1 was 10LDAW4.

The secondary impact (Event 2) involving the back plane of the Toyota and the wood post resulted in minor abrasions to the rear bumper fascia. There was no residual deformation to the bumper. The abrasion marks in the fascia were located 16-28 cm (6.3-11 in) right of the vehicle centerline. The damage was limited to the fascia only and did not extend to the metal of the trunk lid. The CDC assigned for this impact was 06BZLN1. The lack of measurable deformation from this impact invalidated use of the WinSMASH program to determine the severity of the impact. The damage to the back plane is depicted in **Figure 7**.

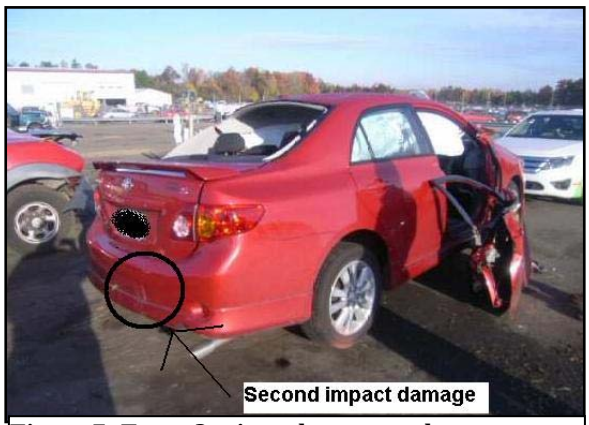

Figure 7: Event 2 minor damage to the rear bumper fascia of the Toyota.

Event Data Recorder

The Event Data Recorder (EDR) of the Toyota was imaged using the proprietary EDR-ROT tool that was provided by Toyota North America, software version 1.4.1.1. The ROT tool imaged the EDR via a direct connection to the Air bag Control Module (ACM) located under the center console, immediately aft of the center instrument panel.

The Toyota EDR was capable of storing three distinct crash events. The distinct events were termed “Latest/Frozen – Bank 0”, “Next Most Recent – Bank 1”, and “Past Max Delta-V – Bank 2”, respectively. Associated to each respective distinct event was a five second pre-crash buffer that recorded Vehicle Speed, Accelerator Pedal Position, Brake Switch Status, and Engine RPM data. The EDR monitored and measured vehicle acceleration in both the longitudinal and lateral direction. The recording of each distinct crash event could be triggered by a frontal (longitudinal) and/or a side (lateral) crash pulse.

The data imaged from the EDR consisted of one distinct crash event labeled “Latest/Frozen – Bank 0”. This data was related to the initial impact with the Ford. A field within the Bank 1 and Bank 2 data sets indicated that the “Record Status” of each bank was in an *Initial State*. No data had been written to these pages and it was determined that these data sets were not related to the investigated crash.

The pre-crash data of the recorded event was labeled "Latest/Frozen – Bank 0". The driver's safety belt was reported as "Belted". The driver's seat track was reported as "RW" or rearward. The front right seat reported as unoccupied and the front right passenger safety belt was reported as "Unbelted". The pre-crash Speed, Engine, Accelerator and Brake data relative to Algorithm Enable (AE) are listed in the following table. The last data sample was assigned the value of AE by the SCI investigator.

Time	-4.3 sec	-3.3 sec	-2.3 sec	-1.3 sec	-0.3 sec	AE
Speed km/h (mph)	24.0 km/h (14.9 mph)	14.0 km/h (8.7 mph)	8.0 km/h (5.0 mph)	10.0 km/h (6.2 mph)	22.0 km/h (13.7 mph)	22.0 km/h 13.7 mph
Engine (RPM)	400	400	400	1200	2400	2400
Accelerator Position	0.78 (OFF)	0.78 (OFF)	0.78 (OFF)	1.29 (OFF)	1.37 (OFF)	0.78 (OFF)
Brake Status	ON	ON	OFF	OFF	ON	ON

The "Latest/Frozen – Bank 0" reported a driver front air bag and a left side impact air bag deployment. The driver's frontal air bag deployed with a "Hi" stage. The deployment time was 10 milliseconds. The front right passenger's air bag was reported as "Not Fired". The writing flag for this bank of data was reported as "Finished Writing".

The "Latest/Frozen – Bank 0" data was linked to three pages of side impact delta-V data. These pages were labeled "Side Crash G B-Pillar", "Side Crash G C-Pillar", and "Side Crash G Floor". The vertical axes of the graphs associated with these pages of data were labeled in units of mph. The maximum delta-V recorded values were 32.8 km/h (20.4 mph) at the B-pillar sensor 18 ms after AE, 6.9 km/h (4.3 mph) at the C-pillar sensor 24 ms after AE, and -27.5 km/h (-17.1 mph) at the floor sensor 54 ms after AE.

Interior Damage

The Toyota sustained moderate-severity damage that was attributed to passenger compartment intrusion, occupant contact, and air bag deployment. **Figure 8** depicts the deformation to the driver's interior. As a result of the initial impact to the left side of the Toyota, the left front and rear doors, A- and B-pillars, left roof side rail, and side panel forward of the A-pillar intruded laterally to the right. The side panel forward of the A-pillar intruded 9 cm (3.5 in). The upper area of the A-pillar intruded 15 cm (5.9 in). The rear upper and rear lower

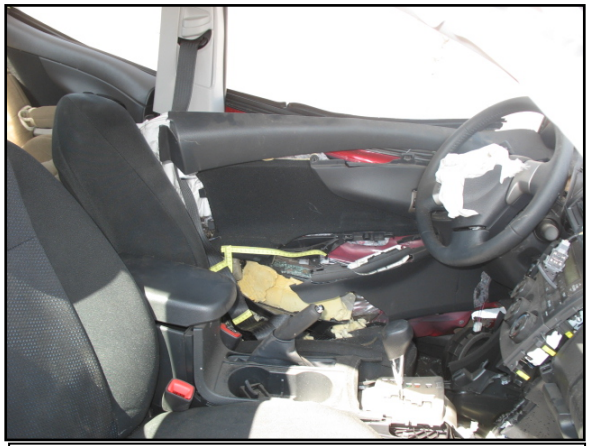

Figure 8: Deformation of the front left seat as a result of intrusion.

quadrants of the left front door intruded 35 cm (13.8 in) and 24 cm (9.4 in), respectively. The door sill intruded 9 cm (3.5 in) laterally, and the front row left roof side rail intruded 22 cm (8.7 in). The B-pillar intrusion measured 19 cm (7.5 in). The forward lower quadrant of the left rear door intruded 23 cm (9.1 in) laterally.

The intrusion resulted in the displacement of the driver's seat 15 cm (5.9 in) to the right and compression of the seat cushion by 13 cm (5.1 in). The seat back deformed CCW 40 degrees. The rear left seat cushion was compressed 12 cm (4.7 in) by the lateral intrusion of the left rear door panel. The driver's head restraint was removed by EMS during the extrication of the driver.

Occupant contact damage was present on the front left door panel, center instrument panel and parking brake. The rear lower quarter of the door panel was fractured as a result of contact with the driver's left hip. This damage was located 7-30 cm (2.8-11.8 in) forward of the rear edge of the door and 28-45 cm (11-17.7 in) below the window sill. The parking brake handle on the center console was deformed by contact from the driver's right hip. The handle had been displaced to the right by 3 cm (1.2 in). The left aspect of the center instrument panel was fractured as a result of contact by the driver's right knee. This damage was located 0-12 cm (0-4.7 in) forward of the face of the instrument panel and 21-31 cm (8.3-12.2 in) above the floor of the Toyota.

Due to passenger compartment intrusion, the steering column was displaced 8 cm (3.1 in) laterally right and the left side of the steering wheel rim was deformed by 3 cm (1.2 in). The left door panel was firmly engaged against the steering wheel rim post-crash. The steering wheel was rotated approximately 560 degrees CCW at the time of the SCI inspection, consistent with the Toyota executing a left turn at an intersection during the impact.

The AS1 windshield was completely fractured with a higher level of damage on the left side. The side windows and backlight were AS2 tempered glass. All left side windows and the backlight were disintegrated by the impact forces. The right rear glazing was undamaged. Emergency personnel removed the windshield by cutting across its upper aspect and along the right A-pillar during extrication of the driver. The right front glazing was also removed by personnel during the extrication process.

The left doors were jammed shut post crash, and the right doors were locked shut. Thus, the right front door was pried open at the B-pillar and cut off its hinges at the A-pillar during the extrication of the driver, evidenced by hydraulic rescue tool marks in those locations at the time of the SCI inspection. The right rear door operated normally.

Manual Restraint Systems

The Toyota was equipped with 3-point lap and shoulder safety belts for the five designated seating positions. All belt systems utilized continuous loop webbing and sliding latch plates. The upper D-rings for the front seats were height adjustable. The front left belt height adjustment was in the full-up position and the front right was in the full-down position at the time of the SCI inspection. The driver's belt retracted onto an Emergency Locking Retractor (ELR), while all other belts retracted onto switchable ELR/Automatic Locking Retractors (ALR). Both front row belts utilized retractor pretensioners. The left pretensioner had actuated during the crash and locked the belt in the used position. The front right pretensioner did not actuate. Measurements of the length of spooled out belt webbing and the location of the contact evidence were not possible due to the inability to access the floor anchor because of left side component intrusions.

Based on crash related evidence on the belt webbing, the post-crash spooled out and locked position of the belt, and supporting EDR data, the driver was restrained by the safety belt at the time of the crash. There was a frictional abrasion 11 cm (4.3 in) in height on the belt webbing, attributed to contact with the driver's chest. The imaged EDR data on the "Latest/Frozen – Bank 0" page reported the driver's belt switch status as "Belted".

Supplemental Restraint Systems

The Toyota was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system that consisted of dual-stage driver and front right passenger frontal air bags, seat track positioning sensors, a front right occupant presence (weight) sensor, front seat retractor pretensioners, and safety belt buckle switch sensors. The manufacturer of the Toyota certified that this vehicle was compliant with the advanced air bag portion of the Federal Motor Vehicle Safety Standard (FMVSS) Number 208. The CAC frontal air bag for the driver's seating position deployed as a result of the initial impact. The front right seating position was not occupied, and as such the front right frontal air bag did not deploy.

The Toyota was equipped with side impact air bags in the upper outboard aspects of both front seat backs, and combination roll-sensing/side impact IC air bags in the roof side rails on both sides of the vehicle. The left side impact air bag and both IC's deployed as a result of this crash.

The driver's frontal air bag **(Figure 9)** was concealed within the center hub of the three-spoke steering wheel by a tri-flap design. The upper cover flap measured 12 cm (4.7 in) in width at the upper aspect, 7 cm (2.8 in) in width at the tear seam, and 7 cm (2.8 in) in height. The upper cover flap contained an oval-shaped Toyota logo that extended into the lower cover flaps. The lower flaps were 4 cm (1.6 in) in width and 10 cm (3.9 in) in height. None of the cover flaps were damaged. The driver's air bag measured 52 cm (20.5 in) in its deflated state. It was vented by two ports on the upper rear aspect of the air bag located at the 11 and 1 o'clock positions.

There were two internal tethers that attached to the 12 and 6 o'clock positions on an 11 cm (4.3 in) diameter center tether at the face of the bag. There was an area of post-crash smeared blood on the face of the air bag, located 7-13 cm (2.8-5.1 in) below the horizontal centerline and 3-7 cm (1.2-2.8 in) left of the vertical centerline.

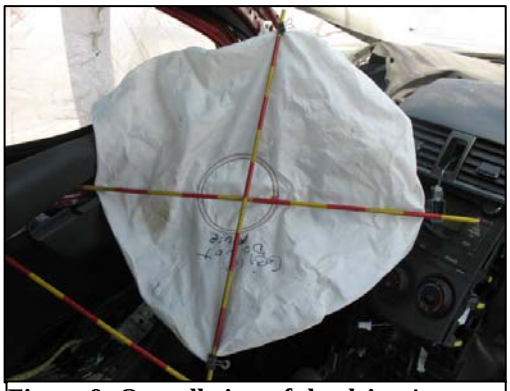

Figure 9: Overall view of the driver's frontal air bag.

The deployed left seat-mounted side impact air bag measured 36 cm (14.2 in) in height and 25 cm (9.8 in) in width. The air bag deployed from a 26 cm (10.2 in) tear seam in the upper outboard aspect of the front left seat back. There was no damage or crash related evidence present on this air bag at the time of the SCI inspection.

The left and right IC air bags deployed from their respective roof side rails as a result of the initial impact. The two IC air bags had symmetrical dimensions of 170 cm (66.9 in) in length, 37 cm (14.6 in) in height at the front seating positions, and 36 cm (14.2 in) in height at the rear seating positions. They were tethered to their respective A-pillars by a 12 cm (4.7 in) long web strap. The web strap on the left IC had been cut by emergency personnel during extrication of the driver. The right web strap was undamaged. The IC air bags provided protection from the C-pillars to a location 29 cm (11.4 in) aft of the A-pillars, and from the roof side rail to below the window sill at the four outboard seating positions. A triangular open area 29 cm (11.4 in) in length and 21 cm (8.3 in) in height was present between the A-pillar and air bag on both sides. Both IC's were labeled with the nomenclature VMQ.PA66, which identified their respective nylon material construction.

The inboard side of the left IC contained a scuff mark attributed to the driver's head in the area adjacent to the front left seating position. **Figure 10** depicts the inboard aspect of the left IC air bag. This scuff mark was located 18-28 cm (7.1-11 in) below the upper aspect of the IC and 46-62 cm (18.1-24.4 in) aft of the forward edge of the IC.

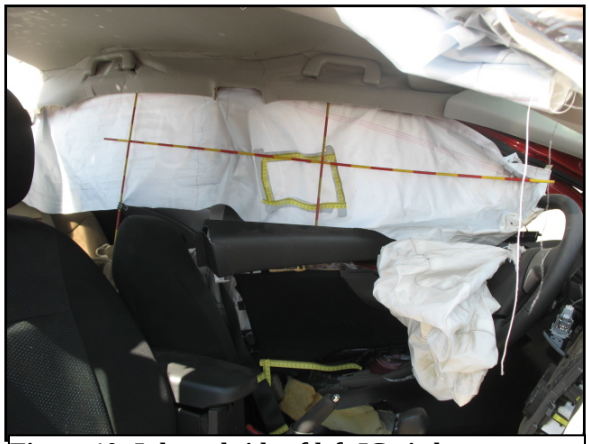

Figure 10: Inboard side of left IC air bag, including driver's head contact.

Child Restraint System

There was an unoccupied Child Restraint System (CRS) present in the rear left seating position at the time of the crash and the SCI inspection. The seat was manufactured by Cosco-Dorel on June 7, 2006 and was identified by the model number 22-248-WAL. The CRS was installed

forward-facing using both the Lower Anchors and Tethers for Children (LATCH) lower anchors and the vehicle's 3-point safety belt routed through the forward-facing belt path of the seat. The CRS was displaced 3 cm (1.2 in) to the right by the intrusion of the rear left door. Official records, in conjunction with an interview of the driver, confirmed that the CRS was not occupied at the time of the crash.

2010 TOYOTA COROLLA OCCUPANTS

Driver Demographics

Age/Sex:	29 years/Male
Height:	180 cm (71 in)
Weight:	93 kg (205 lb)
Eyewear:	None
Seat Type:	Bucket
Seat Track Position:	Mid-track: 4 cm (1.6 in) forward of full-rear
Manual Restraint Usage:	Lap and shoulder belt
Usage Source:	Vehicle inspection and EDR data
Air Bags:	Driver's frontal, left side air bag and both IC's deployed
Alcohol/Drug Involvement:	None
Egress from Vehicle:	Removed from vehicle due to perceived serious injuries
Transport from Scene:	Ground Ambulance
Medical Treatment:	Admitted to a trauma center for 13 days.

Driver Injuries

Inj. No.	Injury	AIS 2005/2008	Injury Source	Confidence Level
1	Pelvic Ring Fracture (including bilateral pubic rami, right sacral wing, coccyx, left ilium and pubic symphysis fractures	856161.3,4	Left door panel, Arm rest/hardware rear lower quadrant	Certain
2	Spleen laceration (multiple lacerations, several are greater than 3 cm in depth)	544224.3,2	Left door panel, Arm rest/hardware rear lower quadrant	Certain
3	Left acetabulum fracture (unstable, comminuted and centrally displaced involving both anterior and posterior columns)	856271.2,2	Left door panel, Arm rest/hardware rear lower quadrant	Certain
4	Right L5 transverse process fracture (non- displaced)	650620.2,8	Seatback	Possible
5	Bladder hematoma (large)	540610.2,8	Seatback	Possible

Inj. No.	Injury	AIS 2005/2008	Injury Source	Confidence Level
6	Scrotum contusion	544010.1,8	Seatback	Possible
7	Arterial vascular injury NFS (in left pelvic area)	821099.1,2	Left door panel, Arm rest/hardware rear lower quadrant (indirect)	Probable
8	Soft tissue injury NFS (to the vertex of scalp)	110099.1,5	Unknown	N/A
9	20 cm (8 in) contusion on left side of face	210402.1,2	Exterior of V2 loaded through IC	Possible
10	Contusion on dorsal side of left arm, shoulder to top of hand	710402.1,2	Left door panel, rear upper quadrant	Certain
11	Hand abrasion NFS	710202.1,9	Frontal air bag	Probable
12	Right knee contusion	810402.1,1	Center instrument panel	Certain
13	Left shoulder abrasion (posterior)	710202.1,2	Left door panel, rear upper quadrant	Probable
14	Left shoulder laceration (minor)	710602.1,2	Left door panel, rear upper quadrant	Probable
15	Left chest contusion	410402.1,2	Left door panel, rear upper quadrant	Certain
16	Left abdominal contusion	510402.1,2	Left door panel, rear upper quadrant	Certain
17	Left hip and thigh abrasion	810202.1,2	Left door panel, Arm rest/hardware rear lower quadrant	Certain
18	Left lower extremity contusion (hip to knee)	810402.1,2	Left door panel, Arm rest/hardware rear lower quadrant	Certain
19	Left lower extremity contusion (knee to ankle)	810402.1,2	Left door panel, forward lower quadrant	Certain

Source of Injury Data: Medical records and Interviewee Data

Driver Kinematics

The 29-year-old male driver of the Toyota was seated in a mid-track position, adjusted 4 cm (1.6 in) forward of full-rear. Both of his hands were positioned on the steering wheel during the execution of the left turn. The driver was restrained by the 3-point manual lap and shoulder safety belt system. He looked, but did not see the Ford prior to the impact. Accordingly, he did not initiate any avoidance maneuver prior to impact.

The left side impact actuated the driver's retractor pretensioner and deployed the driver's frontal, driver seat-mounted side impact, and both IC air bags. The driver initiated a left lateral trajectory within the front left seating position in response to the 10 o'clock direction of force. As the vehicles engaged and the left side of the Toyota was crushed laterally, the left front door, A- and B-pillars, and door sill intruded laterally towards the driver. The driver loaded through the left IC air bag with the left side of his head and loaded the exterior of the Ford, resulting in the contusion to the left side of his face. The left side of the driver's torso loaded the rear lower quadrant of the left door panel, resulting in the spleen laceration. The lower left side of his body loaded the intruding door panel, lower B-pillar and side panel forward of the B-pillar, resulting in the fractured pelvis and the left side contusions.

The driver then initiated a rebound trajectory to the right within the front left seating position. He loaded the center console with the right side of his torso, deforming the parking brake handle. The driver's right knee loaded the left aspect of the lower center instrument panel, fracturing the plastic of the instrument panel and resulting in the knee contusion.

The intrusion of the left side components of the vehicle displaced the driver's seat to the right, which compressed the seat cushion and deformed the seat back. The driver came to rest between the intruded left door panel and the center console, on top of the safety belt buckle. He was still restrained by the lap and shoulder belt.

Emergency response personnel utilized hydraulic rescue tools to remove the right front door to access the driver. The head restraint was removed from the driver's seatback by emergency medical services personnel to facilitate in the process of maintaining spinal immobilization during removal of the driver from the vehicle. Once removed on a backboard, the driver was transported via ground ambulance to a regional trauma center where he was admitted for 13 days. At the time of the interview, 122 days post-crash, the driver was still recovering at home from his injuries. Recovery time was estimated at 12 to 18 months.

1985 FORD F-250

The Ford had been transferred to the same regional vehicle salvage facility as the Toyota, but was sold prior to SCI case initiation. The vehicle salvage facility provided images of the vehicle, which served as the basis for its description and the assessment of its exterior damage.

Description

The 1985 Ford was manufactured in November 1984 and was identified by the VIN 1FTHF2517FNxxxxxx. The five-dial odometer read 87,895 km (54,617 miles) at the time of the crash. The rear-wheel drive Ford was powered by a 6.9-liter V8 diesel engine linked to a four-speed manual transmission. The braking system consisted of power assisted front disc and rear

drum brakes. The recommended tire size for the Ford was LT235/85R16. The Ford was a regular cab, long bed model with a single bench seat across the passenger compartment.

Exterior Damage

The front plane of the Ford sustained moderate damage as a result of the impact (Event 1), as depicted in **Figure 11**. Based on the supplied image, there was an aftermarket front bumper attached to the front of the Ford. The direct contact damage extended across the full width of the front bumper, with maximum crush located at the front left corner. The calculated total delta-V using the Missing Vehicle Algorithm of the WinSMASH program was 29 km/h (18 mph) with longitudinal and lateral components of -29 km/h (-18 mph) and -5 km/h (-3.1 mph), respectively. The CDC assigned for the impact with the Toyota was 12FDEW1.

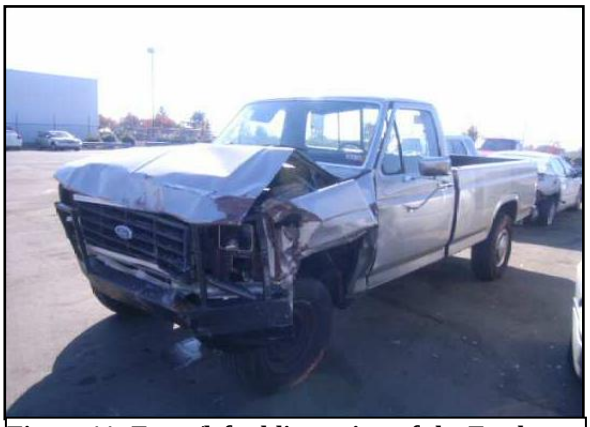

Figure 11: Front/left oblique view of the Ford. Image supplied by the vehicle salvage facility.

1985 FORD F-250 OCCUPANTS

The 25-year-old female driver was the sole occupant of the Ford. She was restrained at the time of the crash by the vehicle's 3-point lap and shoulder safety belt. The driver sustained police-reported possible injuries. She was transported to the Emergency Room of a regional trauma center, which was located near the crash, site for treatment.

SCENE DIAGRAM