

CRASH DATA RESEARCH CENTER

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OFFICE OF DEFECTS INVESTIGATION

**CALSPAN ON-SITE POTENTIAL UNINTENDED ACCELERATION
CRASH INVESTIGATION
SCI CASE NO.: CA10007**

VEHICLE: 2008 TOYOTA AVALON

LOCATION: GEORGIA

CRASH DATE: FEBRUARY 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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<i>16. Abstract</i> This on-site investigation focused on an alleged Unintended Acceleration (UA) of a 2008 Toyota Avalon. The Toyota was driven by an 82-year-old female who purchased the vehicle new in 2008. The driver was attempting to back the Toyota from her carport, when she alleged the vehicle accelerated in reverse. The Toyota exited the driveway and initiated a backing trajectory in a clockwise (CW) arc across the driveway and the adjacent lawn areas. During this backing crash, the Toyota completed a 540 degree trajectory and impacted a lamp post, two garden benches and a tree before the driver brought the vehicle to a stop. At rest, the Toyota was straddling the driveway and the lawn area with the engine running at idle. Acceleration tire marks across the concrete and grass surfaces evidenced the vehicle's backing trajectory. The driver was not injured in this crash. The Toyota was subsequently towed to a local dealership where it was retained for this investigation.			
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BACKGROUND

This on-site investigation focused on an alleged Unintended Acceleration (UA) of a 2008 Toyota Avalon. The Toyota was driven by an 82-year-old female who purchased the vehicle new in 2008. The driver was attempting to back the Toyota from her carport, when she alleged the vehicle accelerated in reverse. The Toyota exited the driveway and initiated a backing trajectory in a clockwise (CW) arc across the driveway and the adjacent lawn areas. During this backing crash, the Toyota completed a 540 degree trajectory and impacted a lamp post, two garden benches and a tree before the driver brought the vehicle to a stop. At rest, the Toyota was straddling the driveway and the lawn area with the engine running at idle (**Figure 1**). Acceleration tire marks across the concrete and grass surfaces evidenced the vehicle's backing trajectory. The driver was not injured in this crash. The Toyota was subsequently towed to a local dealership where it was retained for this investigation.

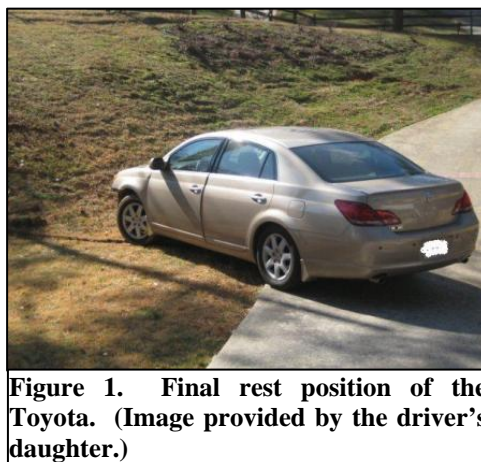


Figure 1. Final rest position of the Toyota. (Image provided by the driver's daughter.)

At rest, the Toyota was straddling the driveway and the lawn area with the engine running at idle (**Figure 1**). Acceleration tire marks across the concrete and grass surfaces evidenced the vehicle's backing trajectory. The driver was not injured in this crash. The Toyota was subsequently towed to a local dealership where it was retained for this investigation.

The driver's daughter filed a complaint of this alleged UA crash through the Auto Safety Hotline on March 1, 2010. The Vehicle Owner's Questionnaire (VOQ) No. 10315232 was forwarded to the Calspan Special Crash Investigations (SCI) team on March 5, 2010 for on-site follow-up. Telephone contact was initiated and cooperation was established with the driver of the Toyota and the dealership that was in possession of the vehicle. The on-site investigation involved a detailed inspection and documentation of the Toyota, an inspection of the accelerator pedal, floor mats, documentation of the crash site, a detailed interview with the driver of the Toyota, and interviews with the owner and service technician of the dealership. In addition, the brakes were inspected and the dealership conducted a diagnostic scan for trouble codes stored in the Toyota. The on-site investigation was conducted during March 9-10, 2010.

SUMMARY

Crash Site

This alleged UA crash occurred at the residence of the driver during daylight hours. **Figure 2** is an overall view of the crash site. The backing crash originated in the attached side-loading carport to the single family residence. The carport was 5.9 m (19.4 ft) in width and 6.2 m (20.3 ft) in depth. The floor of the carport was concrete with a smooth surface. The concrete driveway was curved and extended to a maximum width of 7.8 m (25.6 ft) to the north of the carport. Both edges of the driveway tapered toward the centerline, east of the carport toward the street. The driveway was level in the area of the carport and sloped downward to the east and transitioned to an upward slope toward the cul-de-sac. The driveway grade was a negative 3 percent, measured at the east edge of the carport and increased to a negative 4.2 percent at a point 5.0 m (16.1 ft) east of the carport. In this area, the driveway tapered to a width of 4.9 m (16.1 ft).



Figure 2. Overall view of the crash site and the backing trajectory of the Toyota.

The residential yard located at the north edge of the driveway, opposite the carport, consisted of an unprotected embankment that sloped downward with a negative grade of 30 percent. The vertical height of this embankment was approximately 1.0 m (3.3 ft). This area was covered with ground ivy. Adjacent to the driveway's north edge, east of the ivy, was a lawn area. An embankment with a positive grade of 30 percent bordered this lawn area. This embankment was covered with a mix of grass and mulch and formed a bowl-effect to the backing trajectory of the Toyota. A garden bench and a clay flower pot were located in the center area of the lawn adjacent to the north edge of the driveway.

Located to the south of the driveway and east of the carport was a lawn area with a slight negative grade in the easterly direction. A concrete sidewalk of 1 m (3.3 ft) in width extended from the south edge of the driveway to the front door of the residence. The west edge of the sidewalk was located 7.9 m (25.9 ft) east of the east wall of the carport. A landscaped area that was comprised of a shrub and a lamp post was located at the southeast corner of the sidewalk/driveway juncture. A clay flower pot and a garden bench were positioned on the lawn area between the carport and the sidewalk within the trajectory of the Toyota. Adjacent to the southeast corner of the carport was a landscaped area that consisted of a raised bed with ground cover vegetation and a tree cluster. The tree trunks were approximately 20.3 cm (8.0 in) in diameter and located 2.3 m (7.5 ft) east of the carport.

At the time of this crash, the weather was clear and the temperature was reported at 3.3 degrees C (38.0 degree F). The concrete driveway surface was dry and the dirt within the lawn areas was soft from previous precipitation. A schematic of the crash site is attached as **Figure 21**.

Vehicle Data

The 2008 Toyota Avalon XL was a four-door sedan that was manufactured in March 2008 and was identified by Vehicle Identification Number (VIN): 4T1BK36B78U (production number deleted). The odometer reading at the time of the SCI inspection was 10,138 km (6,300 miles). The Toyota was equipped with a transverse-mounted 3.5-liter, V-6 cylinder gasoline engine linked to a 6-speed automatic transmission with a console-mounted transmission selector lever and front-wheel drive. The transmission was equipped with a manual shift mode. The Gross Vehicle Weight Rating (GVWR) was 2,070 kg (4,565 lb) distributed 1,208 kg (2,665 lb) front and 1,136 kg (2,505 lb) rear. The service brakes were power-assisted, four-wheel disc with antilock. The manufacturer recommended tire size was 215/60R16 with a cold tire pressure of 200 kPa (29 PSI) at both axles. The Toyota was equipped with a direct Tire Pressure Monitoring System (TPMS). The Toyota was equipped with seven-spoke alloy wheels and the OEM Bridgestone Potenza RE92 tires of the recommended size. The maximum inflation pressure of these tires was 352 kPa (51 PSI). All four tires contained the same Tire Identification Number (TIN) of OBX8 PFA 0708. The specific tire data at the time of the SCI inspection was as follows:

Position	Measure Pressure	Measured Tread Depth	Damage
LF	303 kPa (43.5 PSI)	7.1 mm (9/32 in)	None
LR	290 kPa (42.0 PSI)	5.5 mm (7/32 in)	None
RF	262 kPa (38.0 PSI)	6.4 mm (8/32 in)	None
RR	262 kPa (38.0 PSI)	5.5 mm (7/32 in)	None

The Toyota was equipped with a rear bumper-mounted ultrasonic parking assist system. The system consisted of four sensors in the face of the rear bumper fascia and an audible alarm within the passenger compartment. An off-switch was mounted on the lower left aspect of the knee bolster. This switch enabled the driver to turn-off the alarm during a backing maneuver; however, the system recycled to ON at each ignition cycle. This system was operational at the time of the SCI inspection.

The interior of the Toyota was configured with leather-surfaced five passenger seating. The front seats were power-adjustable bucket seats with adjustable head restraints. Both front head restraints were in the full-down positions. The rear bench seat had a split 60/40 right side wide forward folding back. All three rear seat positions were equipped with adjustable head restraints that were in the full-down positions at the time of the SCI inspection. The interior accessories included power outside mirrors, automatic climate control, tilt and telescopic steering wheel, cruise control, speed-sensitive power door locks, and power windows with auto-up for the front doors.

Vehicle History

The driver purchased the Toyota as a new vehicle in April 2008 from a local Toyota/Scion dealership within close proximity to her residence. At the time of

purchase, the odometer reading was 6.4 km (4.0 miles). The service history was brief and included the following:

Service Date	Odometer	Complaint	Repair Description
12/14/2008	2,247 km (1,396 miles)	Check engine light on	Repaired chewed wiring and foam for the temperature sensor, washer fluid bottle cap chewed
3/18/2009	4,469 km (2,777 miles)	Oil and filter change	Oil and filter change
9/25/2009	8,255 km (5,130 miles)	Oil and filter change, rotate tires	Oil and filter change, rotate tires
2/15/2010	9,961 km (6,190 miles)	Accelerator pedal recall	Installed accelerator pedal shim

The driver did not report any previous crashes involving the vehicle. Several areas of superficial previous damage that consisted of scrapes were noted to the rear bumper fascia (corners and centerline areas). These areas were touched-up with color matching touch-up paint.

Crash Sequence

Pre-Crash

On the morning of this alleged UA incident, the driver departed her residence in the Toyota to meet a friend for lunch. This trip involved a round trip travel distance of approximately 6.4 km (4.0 miles) and consumed two hours of time away from her residence. She returned to her residence in the early afternoon and parked the Toyota in the carport on the east side, her usual parking space. Her daughter’s vehicle was parked in the carport to the right of the Toyota. The driver stated that she parked the Toyota without incident and exited the vehicle and proceeded into the side door of her residence located at the back of the carport. Her plan was to change her clothes and gather a few routine items prior to departing her residence within 30 minutes.

The driver stated that she placed the items in a plastic shopping bag and exited her residence. At her departure, she called out to her daughter and informed her that she was leaving. The driver walked to the Toyota and placed the shopping bag and her hand bag on the right front seat cushion. She routinely checked to make sure she had her reading glasses, sunglasses, tissue, and her umbrella. The driver was not wearing eyewear and does not require prescription lenses to drive. She was wearing a leather boot-type shoe with a 5 cm (2 in) heel, size 11M.

The driver stated that she started the Toyota, placed her right foot on the brake pedal, and placed the console-mounted transmission shifter in reverse to back out of the carport. She further stated that she never lifts her foot off the brake pedal as she only backs a short distance to the edge of the driveway before shifting to drive, to steer left and drive forward out of her driveway.

The driver noted that as she released brake pedal pressure to back out of the carport, the Toyota began to accelerate rearward. The physical evidence at the scene indicated the vehicle had backed out of the carport on a slight clockwise arc. There were no acceleration tire marks visible on the floor of the carport or across the driveway north of the carport.

Crash

The Toyota exited the carport (**Figure 3**), traversed the width of the concrete driveway, and departed the north edge of the driveway into the ivy covered embankment (**Figure 4**). The physical evidence consisted of a right front acceleration tire mark that was 0.3 m (1.0 ft) in length on the north edge of the concrete driveway. The front tire marks continued in the ground ivy as the Toyota continued rearward. The front undercarriage of the Toyota bottomed-out in the ground ivy as the vehicle traversed the negative slope of the embankment. The compression of the ivy (similar to a gouge) was located approximately 1.0 m (3.3 ft) north of the driveway edge.



Figure 3. View of the backing trajectory of the Toyota from inside the carport.



Figure 4. Departure from driveway onto the ivy and lawn areas.

The front tires of the Toyota furrowed into the soft ground as the vehicle continued to accelerate rearward onto the lawn area located northeast of the carport. The tire marks supported a continued CW arc of the backing vehicle. The back right undercarriage area gouged the positive slope of the embankment. The chrome tip of the right tailpipe separated from this contact. There was no structural damage to the vehicle. As the back of the Toyota ramped up the embankment, the rear tires slid on the wet surface resulting in a change of direction to the Toyota's trajectory.

The vehicle continued to accelerate rearward as its heading was redirected from an easterly direction to a southerly direction. It should be noted that as the Toyota engaged the cross slope of the embankment, the driver stated that she thought the vehicle was going to overturn.

The Toyota continued rearward as it was redirected in a southerly direction. At this point, the Toyota traveled approximately 180 degrees on a CW arc (**Figure 5**). The diameter of this semi-circular trajectory was 11.3 m (37.1 ft). The vehicle crossed the

driveway in a near tracking attitude. The front tires continued to spin, evidenced by black rubber acceleration marks across the concrete surface. The radius of curvature during this backing trajectory indicated the front tires were turned in a counterclockwise direction, indicative of a left steering input. It is doubtful that the driver initiated the steering input. The steering was induced from the cross slopes of the terrain and the torque applied to the wheels. The driver stated during the interview that she was just hanging on.



Figure 5. Overall view of the vehicle's backing trajectory and the associated physical evidence.



Figure 6. Acceleration tire marks across the driveway, sidewalk, and lawn areas.

As the Toyota crossed the driveway, it continued a backward CW yaw under acceleration. The Toyota entered the front lawn of the residence and traversed the landscaped area at the southeast corner of the driveway/sidewalk junction. The forward aspect of the right front fender area impacted the lamp post (Event 1), deflecting the lamp post in a westerly direction. The frontal area overrode the deflected post. This impact resulted in minimal damage to the vehicle and did not alter the trajectory of the Toyota.

The front tires continued to spin as the vehicle traversed the sidewalk. The lateral offset of the tire marks began to close indicating the vehicle was in a backward CW yaw approaching a near broadside trajectory (**Figure 6**). As the Toyota exited the sidewalk and entered the grassy area in front of the carport, the right side area impacted the clay flowerpot and the garden bench (Event 2). The Toyota continued an additional 3.0 m (9.8 ft) and entered the landscaped area to the east of the carport. The forward aspect of the right front fender impacted the 20.3 cm (8.0 in) diameter tree (Event 3). At impact with the tree, the front tires were tracking laterally as the Toyota continued on a CW yaw. The direction of force for this tree impact was 3 o'clock. The damage algorithm of the WINSMASH program computed a total delta V of 8.0 km/h (5.0 mph). The longitudinal component was 0 km/h and the lateral was -8.0 km/h (-5.0 mph).

The tree impact redirected the center of gravity (CG) of the Toyota from an easterly direction to a northerly direction. This was evident by the front tire marks as they continued to spin across the landscape area back onto the concrete driveway. The acceleration marks extended across the full-width of the driveway on a near straight line trajectory (**Figure 7**). The acceleration marks indicated the vehicle was in a near tracking

attitude as the front tires were redirected in a CW (steering) direction by the tree impact. The Toyota crossed the driveway a third time as the vehicle completed a 360 degree circle.



Figure 7. Acceleration tire marks across the driveway at the completion of 360 degrees of travel.

The Toyota re-entered the lawn area located to the north of the driveway. The front tires continued to spin and furrow into the soft ground. The combination of the soft ground and the positive slope of the terrain induced a CW yaw as the Toyota continued on its backward trajectory. The right side of the Toyota impacted a second garden bench (Event 4) resulting in minor severity damage to the doors and right front fender. This impact did not alter the trajectory of the vehicle. The Toyota traveled up the grass and mulch embankment. The Toyota was redirected from an easterly direction to a southerly redirection as the tires lost traction on the slope. The driver stated that she slammed on the brakes and brought the Toyota to a stop as the vehicle completed approximately 540 degrees of the circular backing trajectory.

The Toyota came to rest straddling the north edge of the driveway with the rear tires on the driveway and the front tires on the lawn area. At rest, the vehicle was facing in a northeasterly direction. The driver maintained brake pedal pressure and the engine remained running at idle speed.

Witness Observations

The driver's daughter was in the residence and heard the driver call out to her as she departed the house. She responded with a "good-bye" and was engaged in her activity. The daughter was unaware of the sequence of events until she heard a whirlwind-type sound from the driveway area. She looked out the window and observed the Toyota at rest, perpendicular to the driveway and straddling the lawn area. The daughter immediately ran to assist the driver. As she approached the Toyota, the daughter observed the driver positioned upright in the front left position and restrained by the manual safety belt system. She further stated that the engine was running at idle speed and the driver's right foot was on the brake pedal. The daughter instructed the driver to place the transmission selector lever in park. She forcibly opened the left front door, reached in and turned-off the Toyota's keyed ignition, and assisted the driver from the vehicle. The daughter, having made a visual assessment of the scene, immediately questioned the driver to determine her mental state. The driver responded appropriately and questioned the daughter on her purpose. The daughter proceeded to the residence and reported the incident to the police.

A neighbor that resides on an adjacent street behind the driver's residence was outside walking his dogs in his backyard. He stated that he heard a loud noise similar to a high performance motorcycle coming from a residential neighborhood. He noted that the noise lasted for a period of 1-2 seconds. After a couple of seconds, he heard the noise

again and it lasted for another 2-3 seconds accompanied by a series of crash-like noises. He looked to the back of his property and observed the Toyota at rest in the driveway. The witness placed his dogs in the house and ran down the embankment to offer assistance. On arrival to the Toyota, the driver's daughter was assisting the driver from the vehicle. This witness assessed the driver's condition as not outwardly panicked or alarmed, and noted that she responded appropriately to the daughter.

Post-Crash

The investigating officer arrived on-scene within minutes of the call and conducted his investigation of the incident. He completed a state Police Crash Report (PAR) and called for tow transport of the Toyota. The Toyota was towed via a flatbed truck to the local Toyota dealership where the driver had originally purchased the car. The driver complained of minor mid abdominal pain and declined medical treatment.

2008 Toyota Avalon

Exterior Damage

The 2008 Toyota Avalon sustained moderate severity damage from this multiple event crash (**Figure 8**). The initial impact event involved the right front fender impacting the lamp post at the driveway/sidewalk juncture. The damage was subsequently masked by the subsequent tree impact. The same area of the vehicle also impacted the garden bench that was positioned on the lawn area between the sidewalk and the carport.



Figure 8. Overall view of the right side damage to the Toyota.

The impact with the 20.3 cm (8.0 in) diameter tree (Event 3) involved the right front fender, the right side of the front bumper fascia, and the right headlamp assembly. The direct contact damage on the right front fender began 47.6 cm (18.75 in) forward of the right front axle and extended 25.4 cm (10.0 in) forward to the leading edge of the fender. The impact crushed the fender to a maximum depth of 19.7 cm (7.75 in) located at the leading edge of the fender. The combined induced and direct contact damage length was 94.6 cm (37.25 in) and involved the full length of the fender. The documented residual crush profile was as follows: C1 = 0 cm, C2 = 1.9 cm (0.75 in), C3 = 3.8 cm (1.5 in), C4 = 8.1 cm (3.2 in), C5 = 9.5 cm (3.75 in), C6 = 19.7 cm (7.75 in).

The lateral impact force of the tree impact displaced the frontal structure minimally to the left resulting in binding of the left front door against the left front fender. The opening of the left front door at the scene produced damage to the trailing edge of the fender. The front bumper fascia and the grille separated from the frontal structure as a result of the tree impact. The fascia and grille came to rest on the lawn area between the sidewalk and the carport. **Figures 9 and 10** are views of the right front fender damage.

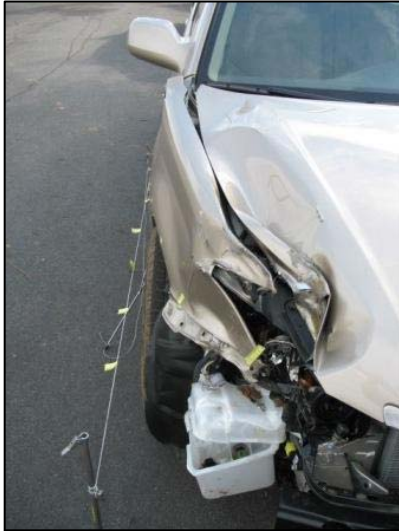


Figure 9. Lateral deformation of the right front fender area.



Figure 10. Tree impact damage to the right front fender area.

Isolated dents and areas of direct contact damage were present on the right side doors from contact with the garden bench that was located in the lawn area adjacent to the north edge of the driveway. The contact damage originated on the trailing edge of the right front fender and extended onto the right front door. The horizontally oriented abrasions on the fender extended 25.4-39.4 cm (10.0-15.5 in) aft of the right front axle and were located 48.3-57.2 cm (19.0-22.5 in) above the ground. The damage to the leading edge of the right front door was located 43.2-80.0 cm (17.0-31.5 in) aft of the right front axle position and was 36.8-57.2 cm (14.5-22.5 in) above the ground. Superficial damage consisting of dents and scuff marks on the right doors in the area of the B-pillar was located 148.6-174.6 cm (58.5-68.75 in) aft of the right front axle and 36.8-78.7 cm (14.5-31.0 in) above the ground. The Collision Deformation Classifications (CDCs) for the impacts are indentified in the following table:

Event No.	Object Contacted	CDC
1	Lamp post	03RFEN1
2	Garden bench	03RFEN1
3	20.3 cm (8.0 in) diameter tree	03RFEN3
4	Garden bench	04RYEW1

Interior Damage

There was no crash related interior damage or passenger compartment intrusion to the Toyota. The driver presumably loaded the safety belt system and the center console; however, there was no evidence of contact to these components.

Vehicle Inspection

The 2008 Toyota Avalon was found parked in the back lot area of the local Toyota dealership. The bumper fascia and grille were separated from the vehicle and were found adjacent to the Toyota. Cooperation was established with the dealership to inspect the

brakes and perform a diagnostic scan for possible codes stored within the vehicle's computer system. A service technician for the dealership started the Toyota and drove the vehicle into the service facility and placed the Toyota on a two post electric/hydraulic lift. The vehicle started without difficulty and idled normally when started by the technician. There were no issues relating to engine speed or brakes as the vehicle was driven into the service facility. A senior level service technician was assigned the tasks of assisting the SCI investigator.

Diagnostic Trouble Codes (DTC)

The technician used a Toyota supplied laptop computer with an integrated docking platform to perform the diagnostic check of the vehicle's computer. The laptop was connected via cable to the Diagnostic Link Connector (DLC) that was located below the driver's knee bolster. The Toyota's VIN was entered into the software to verify the vehicle and provide communication between the scan tool and the vehicle's computer.

The Toyota retained three DTCs; two related to the automatic HVAC system and one related to the external air bag sensor located at the outboard aspect of the right front frame rail. The Toyota technician indicated that the air conditioner DTC codes depicted in **Figure 11** (B1421 and B1424) relate to the solar-sensing system reading artificial lighting in the service facility. The SRS air bag code B1610 indicated a probable fault with the external sensor that resulted from direct contact with the tree impact. It should be noted that the instrument panel air bag indicator light illuminated and remained on during the run-time of the vehicle at the time of the SCI inspection.

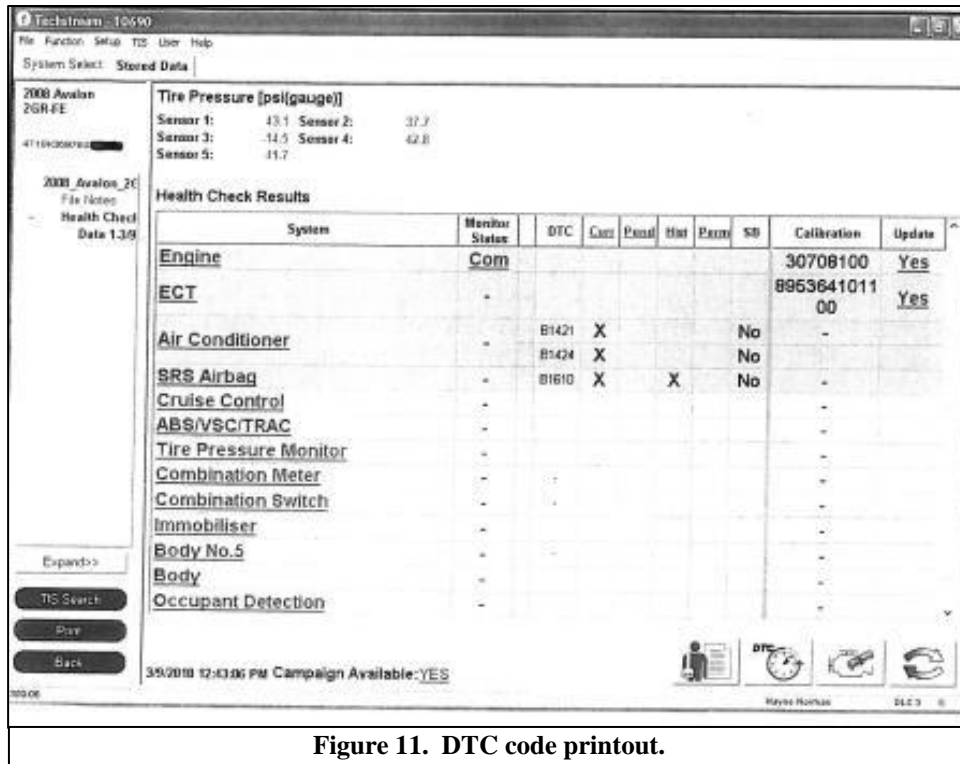


Figure 11. DTC code printout.

Brake Inspection

A preliminary inspection of the exterior condition of the Toyota was performed as the technician was positioning the lift arms. As the Toyota was raised on the lift, all four tires and wheels were visually inspected for evidence of damage; none was found. The brake caliper and rotors were viewed through the spokes of the alloy wheels and all four brake systems appeared to be free of damage and there was no evidence of prolonged heat due to braking.

The technician used a pneumatic impact wrench to remove the five lug nuts from the left front, right front and right rear wheels. The tire/wheels were removed from these positions and the brakes were again inspected. The technician used the pneumatic impact wrench to remove the 14 mm (socket size) caliper bolts from the right front and right rear brake assemblies. He removed the right side calipers and the brake pads. There was no evidence of wear to the OEM metallic brake pads or evidence of heat build-up due to prolonged braking. The right rear pads did exhibit subtle surface rust build-up attributed to nonuse that developed during the two weeks between the incident and the SCI inspection. **Figures 12 and 13** are views of the right front brake system.



Figure 12. Right front rotor and caliper.



Figure 13. Right front brake pads.

Floor Mats

The 2008 Toyota Avalon was equipped with the OEM carpeted floor mats (**Figure 14**) that were dealer installed at the time of the new car delivery to the driver. The mats consisted of a beige carpet top surface bonded to a molded closed cell foam backing. The pliable backing was identified by the following number molded into the backing:

PT548-67050 PPLLC 7P86-L

The driver's floor mat was secured in position by two rear-facing hooks that were secured to the



Figure 14. Position of the OEM carpeted floor mat.

vehicle's carpet. The hooks were positioned through the grommets of the floor mat (**Figure 15**) and the mat was held secure without interference with the accelerator or brake pedals.

The OEM carpet was cut in a U-shaped pattern around the stalk of the accelerator pedal (**Figure 16**). There was no binding or interference of the carpet with the pedal.



Figure 15. Hook protruding through the floor mat.



Figure 16. OEM cutout of carpet behind accelerator pedal.

Accelerator Pedal

The Toyota Avalon was subject to both the Floor Mat recall (NHTSA Campaign No. 09V388000) and the Sticky Pedal recall (NHTSA Campaign No. 10V01700). The accelerator pedal was manufactured by CTS (**Figure 17**). The recall shim was installed in the pedal by the dealership on February 15, 2010. The crash occurred 10 days after the service. At the time of the SCI inspection, the pedal was repeatedly cycled to a full-throttle position and the pedal operated without binding and yielded strong return tension. The pedal was identified by the following nomenclature (**Figure 18**):

78110-07011
08072B3AY
48929819184
LHD



Figure 17. Overall view of the CTS accelerator pedal.



Figure 18. Identification numbers on the CTS pedal.

Vehicle Controls

The Toyota was towed to the dealership and inspected by a representative from Toyota Motors prior to the SCI inspection. It is unknown if the Toyota representative imaged the vehicle's Event Data Recorder. At the time of the SCI inspection, the power driver's seat was adjusted to the full-rear track position.

The ignition was turned to the accessory position and the status of the vehicle controls was checked. The radio was off, the automatic climate control reported an interior temperature reading of 26.1 degrees C (79.0 degrees F) and the fan switch was in position one of seven for the driver's position. The front right fan control was off. The rear defrost switch was off, the wipers were off and the cruise control was in the off-position. The instrument panel indicator warnings activated for low washer fluid and the air bag system.

The console-mounted transmission shifter was gated from the park position to the drive position. The Toyota was equipped with a manual shift mode for the automatic transmission.

Engine Status

The Toyota was started and driven into the dealership service facility by a service technician during the SCI inspection process. The vehicle started immediately and ran momentarily at fast-idle. The technician drove the vehicle into the facility and returned the Toyota to the lot following the diagnostic and brake inspections.

The SCI investigator conducted a test of the engine speed several hours following the above process using the vehicle's tachometer. The exterior ambient temperature at the time of this procedure was 22.7 degrees C (73.0 degrees F). With the transmission selector lever in the park position, the engine started immediately and ran at a fast idle of approximately 1200 Revolutions Per Minute (RPM). Within a 15-20 second period, the engine idle dropped to 1000 RPM, then to 900 RPM and to 800 PRM. At this idle speed, the brake pedal was depressed and the transmission was placed in reverse. The engine speed dropped to approximately 700 RPM (**Figure 19**). The transmission was placed in park and the engine returned to a normal idle speed.

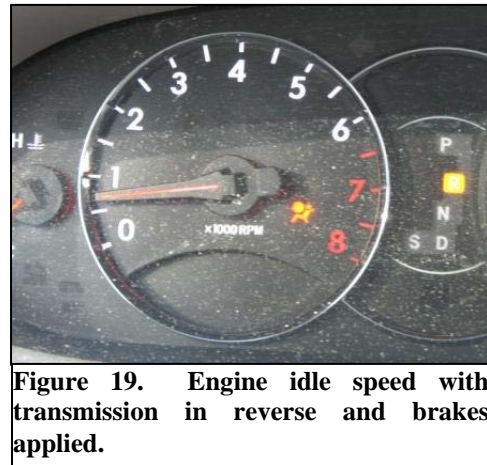


Figure 19. Engine idle speed with transmission in reverse and brakes applied.

Air Bag Systems

The Toyota was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front right passenger positions. The system consisted of dual-stage frontal air bags, seat track positioning sensors, safety belt buckle switches, a front right occupant presence sensor, and safety belt retractor pretensioners. The

manufacturer of this vehicle has certified that the Toyota is compliant to the advanced air bag requirements of Federal Motor Vehicle Safety Standard No. 208. In addition to the CAC air bag system, the Toyota was equipped with a driver's knee bolster air bag. The Toyota was also equipped with front seat back-mounted side impact air bags and roof side rail-mounted inflatable curtain air bags. None of the air bags deployed as a result of this backing crash.

Event Data Recorder

The air bag system was controlled by an Air bag Control Module (ACM) that was mounted to the floor of the center console, forward of the transmission shifter. The ACM provided the functions of crash sensing, diagnostic checks, and Event Data Recording (EDR). The EDR in the 2008 Toyota Avalon did not have the capability to record pre-crash data. The SCI team did not have the hardware or software required to image the EDR at the time of this SCI investigation.

Driver History

The driver of the 2008 Toyota Avalon was interviewed in-person by the SCI investigator. Assisting in the interview process was the driver's adult daughter who was in the residence at the time of this incident. At the time of the interview, the driver was very alert and was fully cognitive of the event and history of the vehicle. The driver is a very independent woman and is in extremely good health. She does not require full-time prescription eyewear and only uses pharmacy grade glasses for reading. The driver is on a daily blood pressure prescription. She denied the use of alcohol or other medications on the day of this incident.

Driver Demographics/Data

Age/Sex: 82-year-old/Female
 Height: 170.2 cm (67.0 in)
 Weight: 63.5 kg (140.0 lb)
 Shoe Size: 11 Medium
 Eyewear: None
 Seat Track Position: Unknown
 Safety Belt Use: 3-point lap and shoulder belt
 Usage Source: Driver interview
 Mode of Egress from Vehicle: Exited with assistance through the left front door
 Type of Medical Treatment: None

Driver Injuries

Injury	Injury Severity (AIS 2005)	Injury Source
Mid abdominal pain	N/A	Safety belt webbing

Source – Driver interview

Driver Kinematics

The driver of the Toyota was seated in an upright posture in an unknown track position. The power-adjustable seat track was in the full-rear position at the time of the SCI inspection. All head restraints were in the full-down positions at the time of the

inspection. The driver stated she was restrained by the manual safety belt. The adjustable D-ring was in the full-up position. The driver was not wearing prescription eyeglasses or sunglasses at the time of the crash. She stated that her right foot was on the brake pedal as she shifted the transmission selector from park to reverse and maintained her foot position on the brake pedal as she began to back out of the carport. **Figure 20** is an overall view of the driver's position.



Figure 20. Overall view of the driver's position.

As the vehicle accelerated rearward and departed the east edge of the driveway, the front undercarriage of the Toyota bottomed out on the negative grade of the ground ivy. This contact would have displaced the driver vertically downward into the seat cushion. As the Toyota continued in reverse and traversed the slopes of her yard, she would have been slightly displaced laterally left and rearward. The right side impacts with the lamp post (Event 1) and garden benches (Events 2 and 4) were of minor severity and probably did not displace the driver.

The subsequent impact event with the tree (Event 3) resulted in a lateral impact force of 3 o'clock and would have displaced the driver to her right. During this trajectory, her torso loaded the safety belt webbing as the inertia-activated retractor presumably locked. Her right hip possibly contacted the center console, although there was no loading evidence on the belt system or the center console. The driver complained of mid abdominal pain from loading the safety belt webbing.

The vehicle crossed the driveway and entered the lawn area, traveling on a counterclockwise arc in reverse. The driver stated that she applied a hard braking force by "slamming on the brakes", bringing the Toyota to a stop. At rest, the Toyota was straddling the east edge of the driveway and the lawn area, facing in a southeasterly direction. At rest, the driver and her daughter stated that the engine of the Toyota was running at idle speed and the transmission selector remained in reverse with the driver's right foot on the brake pedal.

The driver's daughter instructed her from the outside of the vehicle to place the transmission selector lever in park and the daughter forcibly opened the left front door and turn off the keyed ignition. The driver unbuckled the safety belt system and exited the vehicle. She did not complain of injury other than the abdominal pain. The driver refused medical treatment.

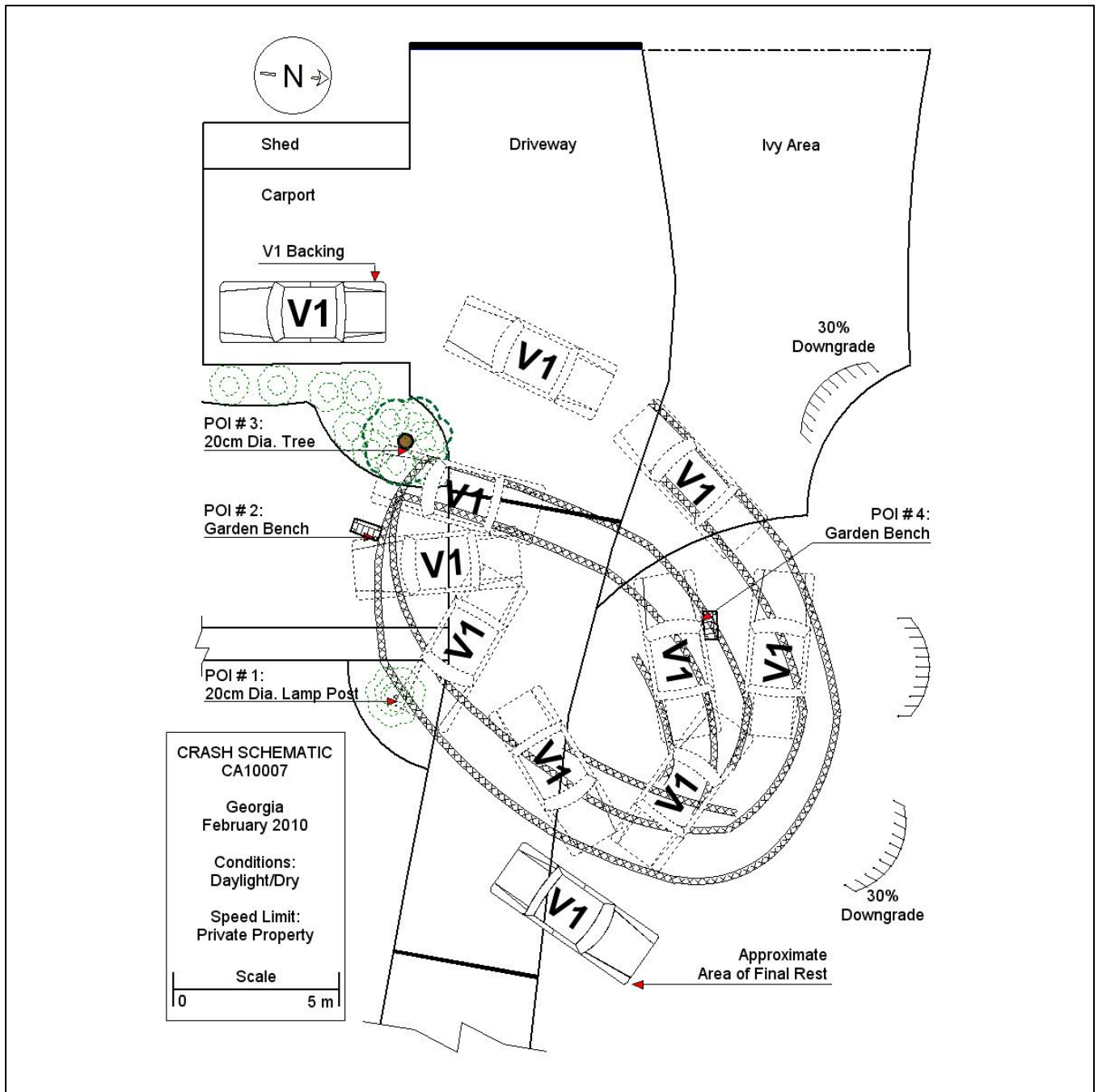


Figure 21. Crash Schematic