Remote Potential Unintended Acceleration Investigation
Special Crash Investigation (SCI)/Office of Defects Investigation (ODI)
Dynamic Science, Inc. (DSI), Case Number DS10011
2007 Toyota Tundra
Washington
October 2007

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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 be 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.

Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient Catalog No.
DS10011		

4. Title and Subtitle	5. Report Date
Remote Potential Unintended Acceleration Investigation	November 12, 2010
	6. Performing Organization Report No.

7. Author(s)	8. Performing Organization Report No.
Dynamic Science, Inc.	

9. Performing Organization name and Address	10. Work Unit No. (TRAIS)
Dynamic Science, Inc. 299 West Cerritos Avenue Anaheim, CA 92805	11. Contract or Grant no. DTNH22-07-00045

12. Sponsoring Agency Name and Address	13. Type of report and period Covered [Report Month, Year]
U.S. Dept. of Transportation (NVS-411) National Highway Traffic Safety Administration 1200 New Jersey Ave, SE Washington, DC 20590	14. Sponsoring Agency Code

15. Supplemental Notes

16. Abstract

This remote investigation was initiated in response to the report of a driver fatality related to the alleged unintended acceleration of a 2007 Toyota Tundra. The restrained 29-year-old driver departed on the right side of a two-lane roadway, impacted wooden fence posts, a phone/cable box, and a large oak tree. The driver was transported from the scene with serious head and torso injuries and died at the hospital 14 hours post-crash.. The subject vehicle was towed from the scene due to damage and was later declared a total loss by the insurance company.

17. Key Words	18. Distribution Statement
Unintended acceleration, fatality, Event Data Recorder	

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No of pages	22. Price

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Crash Investigation
Case Number: DS10011

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BACKGROUND

This remote investigation was initiated in response to the report of a driver fatality related to the alleged unintended acceleration of a 2007 Toyota Tundra (**Figure 1**). The restrained 29-year-old driver departed on the right side of a two-lane roadway, impacted wooden fence posts, a phone/cable box, and a large oak tree. The driver was transported from the scene with serious head and torso injuries and died at the hospital 14 hours post-crash.

Figure 1. 2007 Toyota Tundra (police photo)

Photographs, a police report, and a variety of materials were forwarded to the National Highway Traffic Safety Administration (NHTSA) Office of Defects Investigation (ODI). ODI forwarded the information to the Special Crash Investigations (SCI) group. DSI was assigned the crash on May 17, 2010. The notification occurred 2-1/2 years after the crash.

The father of the Toyota driver was contacted by DSI. The father indicated that approximately five hours after the crash he removed the Event Data Recorder (EDR) from the Tundra and placed it into an evidence bag. He stated that the EDR was lying loose below the center console and the only action required to remove it from the vehicle was to unplug it. The EDR remained in his custody until April 2, 2010. On that date it was air transported to California and placed into the possession of the attorney for the driver's father. The EDR was later taken by the attorney to the Toyota offices near Los Angeles and the data was imaged by Toyota personnel using the Toyota prototype tool on April 8, 2010. The imaging process was videotaped by the attorney. The EDR is in the possession of a forensic engineer associated with the driver's father. A copy of the imaged EDR file was forwarded by the father to DSI. This file was forwarded to NHTSA. The engineer was contacted to arrange for the EDR to be imaged by DSI and/or NHTSA staff. It was later determined by NHTSA that it would not be necessary to re-image the EDR. The standard process of opening the file in the latest version of the prototype software would yield the most up-to-date results.

The subject vehicle was towed from the scene due to damage and was later declared a total loss by the insurance company. It was sold at an insurance auction facility on March 31, 2008 to a private buyer.

Figure 2. Approach to area of roadway departure, eastbound view (police photo)

SUMMARY

Crash Site

This single-vehicle crash occurred in October

2007 at 0155 hours. At the time of the crash the weather was overcast and the roadway was dry. The temperature at the nearest reporting station was 1.0 degree C (33.8 degrees F) and the winds were calm. Visibility was 2.9 km (1.8 miles) and the humidity was 96%. The police report stated there may have been patches of fog. The area where the crash occurred was dark and there were no streetlights present. According to the police report and based on police photos, the roadway in this area was straight and level. The police also reported that the weather was clear and cold, there was frost on the ground, and there was a full moon.

The crash site was a two-lane east/west roadway (**Figure 2**). The lanes were divided by a solid yellow line for westbound traffic and a dashed yellow line for eastbound traffic. The roadway was bordered on both sides by white fog lines and asphalt shoulders. The right edge of the roadway was bordered by a grass shoulder and a three-rail wooden fence. The fence was located approximately 2.7 m (9.0 ft) from the roadway edge. A metal phone/cable box was located near the fence west of a north/south private driveway. The posted speed limit was 72 km/h (45 mph).

Pre-Crash

According to the police investigation, the driver had worked at a hardware store from 0500 to 1600 hours the day before the crash. He returned to his residence and worked on a remodeling project. The distance between his place of work and his residence was 15.7 km (9.8 miles). He departed his residence and traveled to a local sports complex where he participated in a hockey game that began at approximate 2045 hours and ended at 2200 hours. Between 2230 and 2300 hours the driver traveled to a local bar with a friend. The driver reportedly had several drinks while at the bar. The driver's friend departed the bar at approximately 2400 hours.

There was a statement in the police report that the driver may have stopped at a fast-food restaurant on his way home. The distance between the bar and the driver's residence was 19.6 km (12.2 miles).

The Toyota was being driven eastbound at an EDR-reported speed of 120.0 km/h (74.6 mph) five seconds before algorithm enable (AE). For unknown reasons, the Toyota gradually departed the roadway on the right side. As the vehicle departed the roadway it left rolling tire imprints that continued in a straight line for 40.2 m (132.0 ft) before intersecting the wooden fence. There were no indications of any braking or steering maneuvers.

Figure 3. Area of impact with fence (Event 1)

Crash

Based on the EDR-reported speed and roadway departure point, the Toyota traveled for 1.3 seconds off the road before impacting and displacing three sections of the wooden fence and wooden posts (**Figure 3**). The impact resulted in the deployment of the driver's frontal air bag and right inflatable curtain (IC) air bag in the

Toyota. The Toyota continued forward and impacted a phone/cable box (**Figure 4**), crossed a private driveway, and then impacted a large tree (**Figure 5**). The Standard algorithm of the WinSMASH program computed a Total Delta-V of 107.0 km/h (66.5 mph)[1] for the tree impact, based on the estimated crush to the front bumper. This should be considered a borderline reconstruction because of the high speed and the crush estimation.

Figure 4. Impact with phone/cable box (Event 2)

The Toyota rotated 90 degrees in a clockwise direction and came to rest on its wheels facing south with its rear wheels in the eastbound travel lane (**Figure 6**). During the crash the spare tire and drive shaft were displaced from the vehicle. The tire came to rest on the north side of the roadway and the drive shaft came to rest on the right side of the vehicle.

Figure 5. Impact with tree (Event 3)

Post-Crash

The Toyota was towed from the scene due to damage. It was later declared a total loss by the insurance company and later sold to a private party.

The driver remained in his seat post-crash. A passerby arrived on scene shortly after the crash. He observed the truck partially blocking the eastbound travel lane. He parked his truck on the roadway to block oncoming traffic and called 911. He then went to the vehicle to look for injured persons. He was initially unable to see the driver, but did observe an occupant when he got into the back of the pickup and looked through the rear sliding window.

Figure 6. Final rest (looking northeast)

The police arrived on scene at 0209 hours. One of the officers gained access into the passenger compartment by breaking the driver's side window; the other gained access by breaking the passenger window. The officers observed the driver in the driver's seat. He was slumped over the center console. He was unconscious, his breathing was labored, and he had an apparent serious head injury with heavy bleeding. Rescue personnel arrived just as the officer had gained access to

[1] Computed using stiffness values derived from NCAP test 6035

the passenger side of the vehicle. Rescue personnel began treatment, extricated the driver, and transported him to a local hospital where he passed away 14 hours post-crash. According to the medical examiner the cause of death was temporal lobe and brainstem herniation due to large right front subdural hematoma from closed cranial trauma in the motor vehicle accident.

Vehicle Data - 2007 Toyota Tundra

The Toyota was identified by the Vehicle Identification Number (VIN): 5TBRT54197Sxxxxxx. The vehicle was equipped with a 4.7-liter, 8-cylinder engine, automatic transmission, rear-wheel drive, antilock disc brakes, and traction and stability control. The vehicle manufacturer's recommended tire size was P255/70R18 and the recommended cold tire pressure was 228 kPa (33 psi) for the front and rear tires. The vehicle was equipped with Bridgestone Dueller HT P255/70R18 tires on the front and rear. The specific tire information as reported by the police was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	200 kPa (29 psi)	6 mm (8/32 in)	Yes	None
LR	207 kPa (30 psi)	7 mm (9/32 in)	No	None
RR	Tire Flat	6 mm (8/32 in)	No	De-beaded
RF	Tire Flat	6 mm (8/32 in)	Yes	De-beaded

The seating in the Toyota was configured with fabric-covered front bucket seats with adjustable head restraints and a rear bench seat.

Vehicle Damage

Exterior Damage

The Toyota sustained major front end damage from the impacts with the wooden fence posts, phone/cable box, and tree (**Figure 7**). The damage from the fence posts and phone/cable box was masked by the damage from the tree. There was a wooden fence rail embedded into the front right of the vehicle under the headlight casing into the fender. The drive shaft was displaced from the vehicle and was laying on the ground to the right of the vehicle at final rest. The spare tire was displaced from the vehicle and came to rest on the north side of the roadway. Based on the final appearance of the damage the estimated Collision Deformation Classification (CDC) for all three impacts was 12FDEW5. Six crush measurements were estimated at the bumper level as follows: C_1 = 39 cm (15 in), C_2 = 68 cm (27 in), C_3 = 103 cm

Figure 7. Frontal damage (police photo)

(41 in), C_4 = 103 cm (41 in), C_5 = 68 cm (27 in), C_6 = 21 cm (8 in). The partial CDCs for the fence post and phone/cable box impacts were 12F9999 and 12F9999, respectively.

Interior Damage

The Toyota sustained moderate interior damage from intrusion and occupant contacts. The vehicle sustained longitudinal intrusion to the instrument panel and toe pan. There was longitudinal and lateral intrusion to the center console. The steering wheel rim appears to have been deformed longitudinally.

Foot Controls/Floor Mats

Figure 8 is an interior view of the driver's foot controls and floor mat as photographed by the police shortly after the crash. An original equipment manufacturer (OEM) floor mat was installed in the vehicle but it could not be determined if the mat was held in place by the retaining clips. The floor mat consisted of a carpeted top side with TUNDRA embossed on the face and a textured rubber under side. The floor mat was contoured to fit within the left floor pan. Cut-outs at the upper left and right corners of the floor mat allowed space for the dead pedal and the accelerator, respectively. It does not appear that the mat reached the foot controls or impeded their movement.

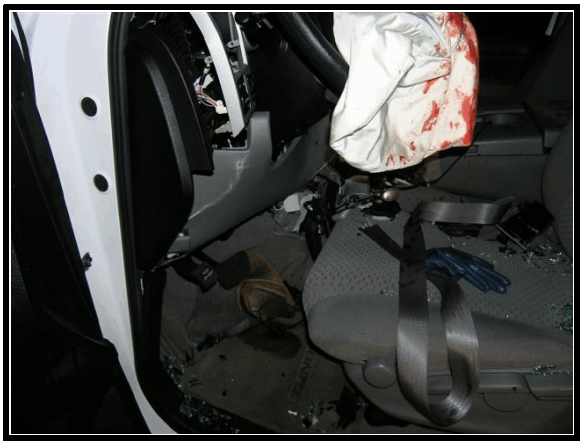

Figure 8. Floor and foot controls (police photo)

The accelerator pedal assembly appears to have been displaced rearward and to the left by intrusion to the toe pan/center console area. According to the police report, the gas pedal had broken away and wedged between the instrument panel and the driver's seat. Based on a metal tab visible in a police photo showing the pedal arm, it is likely that the pedal was manufactured by CTS. The accelerator pedal pad was not visible in any of the police photos. The were no reports that the pedals were manipulated by police for functionality.

Manual Restraints

The vehicle's front row seating was equipped with 3-point manual lap and shoulder belts with sliding latch plates. The driver's safety belt was cut by rescue personnel during the extrication of the driver.

Supplemental Restraint Systems

This vehicle's Supplemental Restraint System (SRS) included a control module, driver and passenger frontal air bags, seat-mounted side airbags for the front row, side impact IC air bags, and retractor-mounted safety belt pretensioners for the front row. The Toyota was a Certified Advanced 208-Compliant (CAC) vehicle and was equipped with advanced frontal air bags. The multi-stage

air bags were certified by the manufacturer to be compliant with the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The driver's air bag was located within the steering wheel hub and the front right passenger air bag was located within the right instrument panel.

During the impact with the fence posts, the driver's frontal and right IC air bags deployed. It is not known if the safety belt pretensioners actuated.

Event Data Recorder

Data in the vehicle's EDR was imaged by Toyota using the EDR Prototype Readout Tool (ROT) in April 2010. The ROT file was emailed to DSI by the driver's father and then viewed using software version 1.4.1.1 of the tool. A summary of the data is included in the following tables.

Data Table	
R/O Deployment Time	No deployment less than 2 sec
Diagnostic Codes	All 0s
Recorded Ama Side	Left Side
Deployment Judgement Side	None Side
Deployment Enabled	Off

Latest/Frozen Bank 0	
Time From Previous Event	5000 ms
Time From Last Pre Crash Data	700 ms
Shift Position	Others
Seat Position Driver	RW[2]
Belt Switch Status Driver	Belted
Belt Switch Status Passenger	Unbelted
Occupant Detection Pasenger	Unoccupied
PAB Manual Cut Off (N/A)	(N/A)
Ignition Cycles	0 times
Lamp On Term	0 minutes
Event Counter	1

[2] Assumed to indicate Rearward

Writing Flag	Finished Writing
Deployment Time	126 ms
Deployment Stage Driver	Hi
Deployment Stage Passenger	Not Fired

Pre-Crash Data						
Time (sec)	-5.0	-4.0	-3.0	-2.0	-1.0	0.3
Speed (mph)	74.6	74.6	74.6	74.6	75.8	74.6
Voltage (v)	1.48	1.48	1.48	1.48	1.52	1.37
Brake	OFF	OFF	OFF	OFF	OFF	OFF
Accelerator	OFF	OFF	OFF	OFF	Middle	OFF
Engine (rpm)	2000	2000	2000	2000	2400	2000

Post-Crash Data	
Maximum Reported Delta-V	1.4 mph at 100 ms

Based on available evidence, it was determined that the air bags deployed during the impact with the wooden fence posts. This deployment is associated with Event Counter 1 as described above. The reasoning for associating this deployment with the fence post impacts is the low Delta-V recorded as compared to the high vehicle speed. As indicated by the EDR, the deployment occurred 126 ms into the crash event where the Delta-V was reported between 1.2 mph (120 ms) and 1.0 mph (130 ms). There may also have been some direct contact to the passenger side impact sensor located on the passenger side inner fender.

The Data Table, Pre-Crash, and Post-Crash data for Event Counter 0 (Next Most Recent) was reported as Not Recorded and contained default data.[3]

The Data Table, Pre-Crash, and Post-Crash data for Event Counter 0 (Past Maximum Delta V) was reported as Not Recorded and contained default data.[3]

Side Crash	
Recorded Ama Side	Left Side
Deployment Judgement Side	Non Side

[3] The default data was consistent with data imaged from two exemplar Tundras involved in frontal crashes. Toyota reported default data is set in this module.

Deployment Enabled	Off
Post-Crash Data (Vel Chg) B-Pillar	-3.9 (mph) at 54 ms[4]
Post-Crash Data (Vel Chg) C-Pillar	-1.6 (mph) at 54 ms
Post-Crash Data (Vel Chg) Floor	-0.7 (mph) at 18 ms

Occupant Demographics - 2007 Toyota Tundra

Driver

Age/Sex:	29/Male
Height:	175 cm (69 in)
Weight:	84 kg (185 lbs)
Seat track position:	Rearward (per EDR)
Manual restraint usage:	Lap and shoulder belt used
Usage source:	Police photos of vehicle interior. Seat belt webbing cut during extrication. Belted according to EDR.
Alcohol, drug involvement:	Positive for alcohol, BAC 0.08. No drugs found in specimen.
Type of medical treatment:	Transported, hospitalized, deceased 14 hours post-crash

Occupant Kinematics

Driver Kinematics

The 29-year-old male driver was seated in an unknown posture and was wearing the manual 3-point lap and shoulder belt. For unknown reasons, the vehicle drifted off the right side of the roadway. There were no indications of braking or steering. At impact with the fence posts the driver's frontal air bag deployed. The scene photos show that the posts were sheared off as the vehicle traveled forward. The driver was displaced forward minimally and likely contacted the deployed air bag. The impact with the phone/cable box was also a low Delta-V event and the driver was displaced forward minimally. After displacing the last pole, the vehicle crossed a private driveway and impacted a large tree with its front end. The driver was displaced forward and slightly to the right. He loaded the lap and shoulder belt and contacted the lower instrument panel with both knees. He sustained bilateral pelvic fractures, a right knee laceration, and a right tibia fracture. He also contacted the steering wheel rim, causing facial fractures and head injuries. As the vehicle began

[4] Velocity Changes for B-pillar, C-pillar, and Floor represent the maximum recorded values.

a clockwise rotation, the driver was displaced to the right.

Occupant Injuries

Driver: Injuries obtained from history and physical report and autopsy report.

Injury	AIS Code	Injury Mechanism	Confidence Level
Large right subdural hemorrhage	140656.5,1	Steering wheel rim	Probable
Global cerebral edema	140660.3,9	Steering wheel rim	Probable
Bilateral temporal lobe herniation and conus (not coded, result)			
Left mandible fracture	250600.1,2	Steering wheel rim	Probable
Right maxillary and orbit fracture	250800.2,1 251200.1,1	Steering wheel rim	Probable
Left wrist dislocation-fracture	751430.2,2	Left instrument panel	Possible
Right tibial fracture (open), puncture would anterior mid right tibia, 1.5 x 0.3 cm (0.6 x 0.1 in)	853405.3,1	Lower instrument panel	Probable
Fracture, right 5th rib	450212.1,1	Steering wheel rim/hub	Probable
Right pulmonary contusion	441402.3,1	Steering wheel rim/hub	Possible
Right knee laceration, horizontal, 4.2 cm (1.7 in)	890600.1,1	Lower instrument panel	Probable
Abrasion, left lateral abdomen overlying superior anterior iliac crest	890202.1,2	Seat belt webbing	Possible
Unstable bilateral pelvic fractures, right closed, left NFS	852602.2,1 852600.2,2	Left instrument panel	Probable
Bilateral contusions to upper and lower eyelids	297402.1,1 297402.1,2	Driver's air bag	Possible
Laceration, anterior chin, 4.0 cm (1.6 in)	290602.1,8	Steering wheel rim	Probable
Subcutaneous hemorrhage, left ankle, 6.5 cm (2.5 in)	890402.1,2	Unknown	Unknown

Attachment 1. Scene Diagram