

Child Safety Seat/Rollover Investigation
Dynamic Science, Inc. / Case Number: DS07016
2005 Toyota Tundra
Arizona
February 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.

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16. Abstract <p>This on site investigation focused on a 2005 Toyota Tundra during a rollover crash and a booster safety seat that was installed in the second row right seat. This single vehicle crash occurred in February 2007 at 1436 hours. The crash occurred on a curved two-lane state highway. It was snowing at the time of the crash. The speed limit at this location was 89 km/h (55 mph). The case vehicle was a 2005 Toyota Tundra access cab pickup that was being driven by a restrained 37-year-old male. There were three additional occupants in the vehicle. The front right seat was occupied by a restrained 36-year-old female. The second row middle seat was occupied by a 6-year-old female. The second row right seat was occupied by a 3-year-old male who was seated in a booster safety seat. The Toyota Tundra was traveling northbound at a police reported speed of 89 km/h (55 mph) and was entering a left hand curve. The driver lost control of the vehicle due to the slippery road conditions. The Toyota Tundra departed the roadway on the right side and began traveling down an embankment. The right front of the Tundra probably contacted a juniper tree on the embankment. The Tundra began a clockwise rotation and the vehicle tripped and rolled over on its left side. The driver indicated that no one sustained any injuries. The Toyota Tundra was towed from the scene due to damage. It was later declared to be a total loss by the insurance company.</p>				
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BACKGROUND

This on site investigation focused on a 2005 Toyota Tundra (**Figure 1**) during a rollover crash and a booster safety seat that was installed in the second row right seat. This single vehicle crash occurred in February 2007 at 1436 hours. The crash occurred on a curved two-lane state highway. It was snowing at the time of the crash. The speed limit at this location was 89 km/h (55 mph). The case vehicle was a 2005 Toyota Tundra access cab pickup that was being driven by a restrained 37-year-old male. There were three additional occupants in the vehicle. The front right seat was occupied by a restrained 36-year-old female. The second row middle seat was occupied by a 6-year-old female. The second row right seat was occupied by a 3-year-old male who was seated in a booster safety seat. The Toyota Tundra was traveling northbound at a police reported speed of 89 km/h (55 mph) and was entering a left hand curve. The driver lost control of the vehicle due to the slippery road conditions. The Toyota Tundra departed the roadway on the right side and began traveling down an embankment. The right front of the Tundra probably contacted a juniper tree on the embankment. The Tundra began a clockwise rotation and the vehicle tripped and rolled over onto its left side. The driver indicated that no one sustained any injuries. The Toyota Tundra was towed from the scene due to damage. It was later declared to be a total loss by the insurance company.



Figure 1. 2005 Toyota Tundra

This Rollover/Booster Safety Seat case was identified by the National Highway Traffic Safety Administration (NHTSA) during a review of police reports. DSI was faxed the report on April 7, 2007. DSI located the case vehicle and obtained permission to inspect the vehicle on April 19, 2007. DSI was assigned the case on April 19, 2007 and the field work was completed during the week of April 22, 2007.

SUMMARY

Crash Site

This single vehicle crash occurred in February 2007 at 1436 hours. The crash occurred on a curved portion of a two-lane state highway (**Figure 2**). At the time of the crash, it was snowing and the asphalt roadway was snow and slush covered. There was a slight uphill grade in the area of the roadway departure.



Figure 2. Approach to area of roadway departure (north)

The north/south roadway was configured with single lanes in each direction that were separated by a double-yellow painted centerline. The speed limit at this location was 89 km/h (55 mph).

Pre Crash

The case vehicle was a 2005 Toyota Tundra access cab pickup that was being driven by a restrained 37-year-old male. There were three additional occupants in the vehicle. The front right seat was occupied by a restrained 36-year-old female. The second row middle seat was occupied by a 6-year-old female. The second row right seat was occupied by a 3-year-old male who was seated in a booster safety seat. The Toyota Tundra was traveling northbound at a police reported speed of 89 km/h (55 mph) and was entering a left hand curve. The driver lost control of the vehicle due to the slippery road conditions.

Crash

The Toyota Tundra departed the roadway on the right side and began traveling down an embankment. The right front of the Tundra probably contacted a juniper tree on the embankment. There were scrapes on the front right portion of the front bumper fascia. The Tundra began a clockwise rotation and the vehicle tripped and rolled over on its left side. The vehicle came to rest on its left side, facing south, approximately 31 m (100 ft) off the roadway.

Post Crash

According to the driver, there were no injuries to any of the occupants. All of the occupants remained in the vehicle until rescue personnel arrived. The rescue personnel removed the windshield during the extrication process.

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

Vehicle Data - 2005 Toyota Tundra

The 2005 Toyota Tundra Access Cab SR5 4x2 pickup was identified by the Vehicle Identification Number (VIN): 5TBRT341X5Sxxxxxx. The vehicle's odometer could not be read because there was no power to the instrument panel. The Toyota Tundra was a four-door pickup that was equipped with a 4.7 liter, 8 cylinder engine, an automatic 5-speed transmission, rear wheel drive, front disc/rear drum brakes with ABS, power steering, and a tilt steering wheel. Electronic Stability Control (ESC) was available for the Tundra as an option, but was not present for this vehicle. The Tundra was configured with BF Goodrich Rugged Trail T/A P255/70R16 tires. The tire manufacture's recommended maximum pressure was 240 kPa (55 psi). The specific tire information is as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	Tire Flat	2 mm (3/32 in)	No	Debeaded, rim chipped
LR	Tire Flat	2 mm (2/32 in)	No	Debeaded
RR	228 kPa (33 psi)	2 mm (2/32 in)	No	None
RF	241 kPa (35 psi)	2 mm (3/32 in)	No	None

The seating in the Toyota Tundra was configured with fabric covered front bucket seats with adjustable head restraints and a rear bench seat. The driver's seat was located in the fully forward track position. The front right seat was located two settings rear of full forward. The driver's seat back angle was 25 degrees from the vertical and the seat cushion was 13 degrees from the horizontal. The front right seat back angle was 33 degrees from the vertical and the seat cushion was 13 degrees from the horizontal. The rear bench seat back angle was 20 degrees from the vertical and the seat cushion was 9 degrees from the horizontal.

Vehicle Damage

Exterior Damage - 2005 Toyota Tundra

The 2005 Toyota Tundra sustained minor contact damage on the front right side of the bumper fascia (**Figure 3**). The direct damage began at the bumper corner and extended 30.0 cm (11.8 in) rearward down the right side plane. There were light scratches found on the hood and roof. There was also direct contact damage above the beltline on the right side. The damage began at the B-pillar and extended 67.0 cm (26.4 in) rearward along the right roof rail (**Figure 4**). These irregular contacts are possibly due to a glancing impact with a tree and its branches. The police report indicated that a large juniper tree was struck as the vehicle left the roadway. The Collision Deformation Classification (CDC) for this impact was 12RYAS2.

The Toyota Tundra also sustained moderate damage to the left side as a result of the rollover on the embankment (**Figure 5**). The direct damage began at the left rear bumper corner and extended 509.0 cm (200.4 in) forward along the left side plane. The maximum crush was located at C3 and measured 12.0 cm (4.7 in). The CDC for this impact was 00LDDO2.

Both left side tires were flattened during the tripping/rollover. There was grass in the bead of the front right tire. The bottom of the tailgate was separated from the bed on both sides (**Figure 6**).



Figure 3. Front right, 2005 Toyota Tundra



Figure 4. Right side damage



Figure 5. Left side rollover damage



Figure 6. Damage at the tail gate area

Interior Damage - 2005 Toyota Tundra

The 2005 Toyota Tundra sustained minor interior damage as a result of passenger compartment intrusion. The C-pillar intruded 4 cm (1.6 in) into the passenger compartment laterally. The windshield was cracked from impact damage and was removed to aid in extrication. Both right side windows and the left rear window were disintegrated. The outboard portions of the three part backlight were also disintegrated. All the doors remained closed and operational.



Figure 7. Overview of front row seating



Figure 8. Overview of second row seating

Manual Restraints - 2005 Toyota Tundra

The 2005 Toyota Tundra was configured with 3-point manual lap and shoulder belts for all five seating positions. Both front seat safety belts were equipped with retractor pretensioners and adjustable D-rings that were in the full up position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The remaining outboard safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The second row center safety belt may have had a switchable retractor but it would not switch to ALR. The rear right safety belt was used in conjunction with the forward facing booster seat. There were no indications of loading or other physical evidence found on the seat belts. Based on interview data from the driver, all the occupants were using their respective safety belts. The second row outboard seating positions were equipped with the lower anchor points that are part of this vehicle's Lower Anchors and Tethers for Children (LATCH) system.

Supplemental Restraint Systems - 2005 Toyota Tundra

The 2005 Toyota Tundra was equipped with frontal air bags that did not deploy.

Booster Safety Seat

Evenflo Big Kid Booster Seat

An Evenflo Big Kid Booster Seat was positioned in the second row right position of the Toyota Tundra (Figure 9). The model number was 3351463A and the date of manufacture was November 18, 2003. The booster seat was designed to be used with or without the detachable seatback. The manufacturer's owner manual recommends the booster seat usage as follows:

With Seatback:

- 30-100 lbs (13.6 - 45.3 kg)
- Less than 57 inches (145 cm) tall
- Child is at least one year old or older

Without Seatback:

- 40-100 lbs (18.1 - 45.3 kg)
- Less than 57 inches (145 cm) tall
- Child is at least one year old or older
- Ears below top of vehicle seat back

The booster seat was being used with the seatback at the time of the crash. The child weighed less than the recommended weight by 2.3 kg (5 lbs), although he did meet the height and age recommendations.

Prior to the crash, the child had been placed in the booster seat by the driver. The arm rests were in the lower of the two available positions. The lap and shoulder belt was used in conjunction with the booster seat. The belt webbing was routed through the right upper shoulder belt guide and the retractor was in the ELR mode. According to the interviewee, the belt was snug against his collarbone. The lap portion of the webbing was routed across the lower belt guides. There were no indications of loading to the seat belt webbing. There were indications of historical usage.

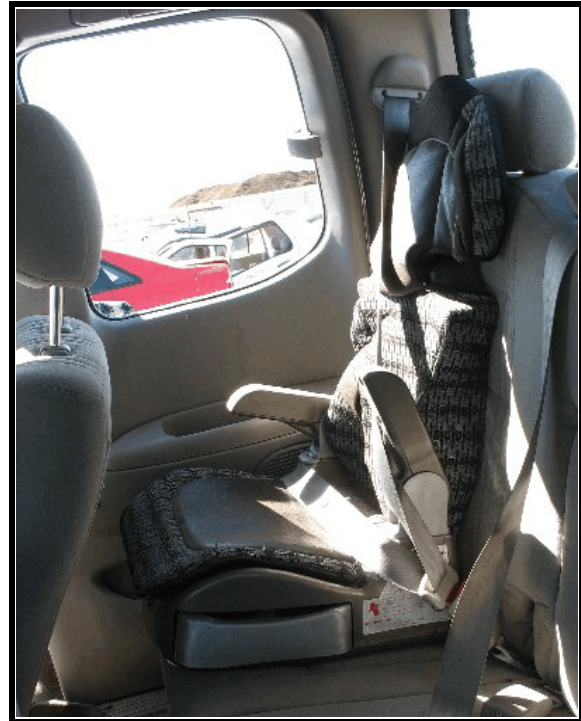


Figure 9. Big Kid Booster seat positioned in second row right.



Figure 10. Evenflo Big Kid Booster Seat. Damage to upper right seatback.

During the inspection, the booster seat was found unsecured in the second row left seat. It was later positioned in its pre-crash position for examination of the belt routing and photographic documentation.

The seatback was deformed and creased on the upper right side (**Figure 10**). The source of the damage is not known. This damage may have been caused by some interaction between the shoulder belt and the upper belt guide, but more likely occurred during the extrication process. The left arm rest was found in the UP position but was not damaged. It was likely moved as the seat belt was unbuckled and taken off the child.

OCCUPANT DEMOGRAPHICS - 2005 Toyota Tundra

	Driver	Front row right occupant
Age/Sex:	37/Male	36/Female
Seated Position:	Front left	Front right
Seat Type:	Bucket	Bucket
Height:	178 cm (70 in)	152 cm (60 in)
Weight:	86 kg (190 lbs)	50 kg (110 lbs)
Alcohol/Drug Involvement:	None	None
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, unknown clock direction.	Unknown
Foot Position:	Right foot on brake, left on floor.	Unknown
Restraint Usage:	Lap and shoulder belt available, used.	Lap and shoulder belt available, used.
Air bag:	Frontal air bag available, did not deploy.	Frontal air bag available, did not deploy.

	Second row middle occupant	Second row right occupant
Age/Sex:	6/Female	3/Male
Seated Position:	Second row center	Second row right
Seat Type:	Bench	Bench
Height:	122 cm (48 in)	76 cm (30 in)
Weight:	16 kg (36 lbs)	11 kg (25 lbs)
Alcohol/Drug Involvement:	N/A	N/A
Body Posture:	Normal, upright	Upright in booster seat
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used with booster seat

OCCUPANT KINEMATICS

Driver Kinematics

The 37-year-old male driver was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. The seat was positioned at the forward most track position. As the Tundra departed the roadway on the right side, the driver probably attempted to steer and brake. At impact with the tree, there was little movement of the occupant. As the vehicle began to rotate clockwise, the driver was displaced to the left. As the vehicle tripped and overturned onto its left side, the driver probably loaded the door side panel. There were no reported injuries, however.

Front Row Right Seat Occupant Kinematics

The 36-year-old female front right occupant was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. The seat was positioned to the mid track position. At impact with the tree, there was little movement of this occupant. As the vehicle began to rotate clockwise, she was displaced to the left. As the vehicle overturned onto its left side, she possibly contacted the driver. The police reported that this occupant had a non-incapacitating injury, but the interviewee stated that she was not injured.

Second Row Middle Seat Occupant Kinematics

The 6-year-old female second row middle occupant was seated in an upright posture and was restrained by the 3-point manual lap and shoulder belt. As the vehicle began to rotate clockwise, she began moving to the left. As the vehicle tripped and rolled onto its left side, she may have been contacted by the booster seat to her right, based on her proximity to the booster seat. There were no reported injuries.

Second Row Right Seat Occupant Kinematics

The 3-year-old male second row right occupant was seated in an upright posture in a forward facing booster seat and was restrained by the vehicle's 3-point manual lap and shoulder belt. The tree impact did not have any effect on this occupant. As the vehicle began to rotate clockwise, this he began moving to the left. As the vehicle tripped and rolled onto its left side, he was displaced in that direction. There were no indications that he contacted anything or anyone in the vehicle.

OCCUPANT INJURIES - 2005 Toyota Tundra

According to the driver, there were no injuries to any occupants of this vehicle.

Attachment 1. Scene Diagram

