

Certified Advanced 208 Compliant Vehicle Investigation / Vehicle to Vehicle  
Dynamic Science, Inc. / Case Number: DS05031  
2006 Toyota Tacoma  
Colorado  
November 2005

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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  This on site investigation focused on the air bag system in a Certified Advanced 208-Compliant (CAC) vehicle (2006 Toyota Tacoma pickup). A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Standard (FMVSS) No. 208. The case vehicle was being driven by an unrestrained 22-year-old male. The other vehicle was a 1966 Ford F250 pickup truck that was being driven by a 52-year-old male. The front right seat was occupied by a 19-year-old male. The Toyota Tacoma was traveling westbound. The Ford pickup was traveling eastbound. The Toyota Tacoma changed lanes to pass a non-contact vehicle. The driver of the Ford pickup braked and steered to the right to avoid the impact. The front of the Toyota Tacoma struck the front of the Ford. The driver's air bag in the Toyota Tacoma deployed at this point. The driver of the Tacoma was fatally injured. According to the autopsy report he sustained lacerations and abrasions to his face; lacerations of the right atrium, liver, and spleen; bilateral lung contusions, hemothorax, and hemoperitoneum; abrasions, contusions, and lacerations of his extremities; and a fracture and dislocation of the left patella. He was pronounced dead at 0950 hours; approximately one hour post-crash.					
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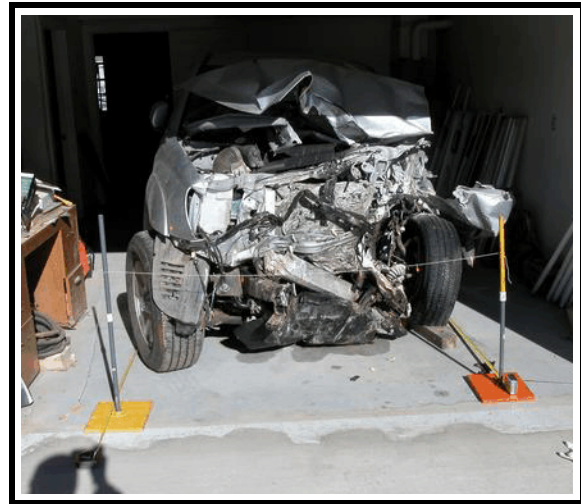
**Dynamic Science, Inc.**  
**Crash Investigation**  
**Case Number: DS05031**

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## BACKGROUND

This on site investigation focused on the air bag system in a Certified Advanced 208-Compliant (CAC) vehicle (2006 Toyota Tacoma pickup). A CAC vehicle is certified by the manufacturer to be compliant to the Advanced Air Bag portion of the Federal Motor Vehicle Standard (FMVSS) No. 208. The case vehicle was being driven by an unrestrained 22-year-old male. The other vehicle was a 1966 Ford F250 pickup truck that was being driven by a 52-year-old male. The front right seat was occupied by a 19-year-old male. The Toyota Tacoma was traveling westbound. The Ford pickup was traveling eastbound. The Toyota Tacoma changed lanes to pass a non-contact vehicle. The driver of the Ford pickup braked and steered to the right to avoid the impact. The front of the Toyota Tacoma struck the front of the Ford. The driver's air bag in the Toyota Tacoma deployed at this point. The driver of the Tacoma was fatally injured.



**Figure 1.** 2006 Toyota Tacoma

This CAC case was initiated as a possible air bag related driver fatality investigation. The case was initiated in response to a notification to DSI from the Colorado State patrol. The notification occurred during the course of an ongoing SCI investigation in the same area. DSI was notified on December 12, 2005. NHTSA was notified later that day. DSI was assigned the case on December 14, 2005. The case vehicle was inspected on December 15, 2005. The electronic data recorder was not harvested since the vehicle was being held as evidence.

## SUMMARY

### Crash Site

This two vehicle crash took place in December, 2005 at 0845 hours. The crash took place in a rural area in southern Colorado on a curved, two-lane US highway. There is two-way, east/west travel on the asphalt roadway. The two lanes are separated by solid/dashed yellow lines that prohibit passing in the westbound direction. The roadway is bordered on the south side by an asphalt shoulder. Just to the right of the shoulder there is a steep, grass-covered embankment. The roadway is bordered on the north side by an asphalt shoulder. Just to the right of this shoulder there is a shallow, grass-covered embankment. There is a slight (<1%) down grade when traveling from west to east. The weather was clear and the roadway was dry and free of defects. The speed limit is 97 km/h (60 mph).

## Pre-Crash

The case vehicle is a 2006 Toyota Tacoma pickup truck that was being driven by an unrestrained 22-year-old male (170 cm/67 in, 73 kg/160 lbs). The Tacoma was equipped with dual front air bags. The front right passenger's air bag was controlled by a cut off switch that was in the AUTO position. The other vehicle is 1966 Ford F250 pickup truck that was being driven by a 52-year-old male. The front right seat was occupied by a 19-year-old male. The Toyota Tacoma was traveling westbound at an unknown speed. The Ford pickup was traveling eastbound. A non contact vehicle was traveling in front of the case vehicle and was also traveling westbound.



**Figure 2.** Area of impact—facing east

The driver of the Toyota Tacoma changed lanes to the left into the eastbound travel lane in an attempt to pass the non contact vehicle. The driver of the Ford saw the Tacoma and began steering to the right and braking—depositing 10 m (38 ft) of locked wheel skids.

## Crash

The front of the Tacoma struck the front of the Ford in a head-on configuration. The barrier routine of the WinSmash program computed a total delta V of 73.6 km (45.7 mph)<sup>1</sup>. The longitudinal and lateral components were -73.3 km/h (-45.5 mph) and -6.4 km/h (-4.0 mph), respectively. The driver's air bag in the Tacoma deployed at this point.

## Post-Crash

The Tacoma rotated in a counterclockwise direction and came to rest with the front wheels on the southern shoulder facing south. The Ford rotated in a counterclockwise direction and came to rest just south of the roadway, on the embankment, facing north.

The driver of the Tacoma was fatally injured. According to the autopsy report he sustained lacerations and abrasions to his face; lacerations of the right atrium, liver and spleen; bilateral lung contusions, hemothorax and hemoperitoneum; abrasions, contusions, lacerations of the extremities; and a fracture and dislocation of the left patella. He was pronounced dead at 0950 hours; approximately one hour post-crash. The driver and front right occupant of the Ford were transported to a local hospital. Their treatment status is not known. The police reported that they sustained “incapacitating injuries”.

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<sup>1</sup>Calculated using stiffness values derived from NCAP test 5312 for a 2005 Toyota Tacoma.

**VEHICLE DATA -2006 Toyota Tacoma**

The 2006 Toyota Tacoma was identified by the Vehicle Identification Number (VIN): 5TEUU4ZN86Zxxxxxx. The Toyota Tacoma club cab pickup was equipped with a 4.0 liter V6 engine, a 5-speed manual transmission, 4-wheel Anti-lock Brake System (ABS) with Electronic Brake-force Distribution (EBD) and Brake Assist, front disc/rear drum brakes, and power steering. The Tacoma was configured with Bridgestone Dueler HT P265/65R17 tires. The manufacturer recommended cold tire pressure was 200 kPa (29 psi). The specific tire information is as follows:

<b>Position</b>	<b>Measured Pressure</b>	<b>Measured Tread Depth</b>	<b>Restricted</b>	<b>Damage</b>
LF	Flat	8 mm (10/32 in)	Yes	Cut
LR	103 kPa (15 psi)	8 mm (10/32 in)	No	None
RR	290 kPa (42 psi)	8 mm (10/32 in)	No	None
RF	262 kPa (38 psi)	7 mm (9/32 in)	No	None

The seating in the Toyota Tacoma was configured with cloth covered front bucket seats with adjustable head restraints and a rear bench seat. The driver's seat was located 12.0 cm (4.7 in) rear of the full forward track position (between mid and fully forward). The front right seat was located 21.0 cm (8.3 in) rear of the full forward track position (between mid and fully forward). At the time of the vehicle inspection, the driver's seat back was at a 68.8 degree angle and the seat bottom was at a 7.2 degree angle; the front right passenger's seat back was at an 80.0 degree angle and the seat bottom was at an 11.4 degree angle.

## VEHICLE DAMAGE

### Exterior Damage - 2006 Toyota Tacoma

**Damage Description:** The 2006 Toyota Tacoma sustained major front end damage as a result of the impact with the Ford pickup. The direct damage began at the front left bumper corner and extended laterally across the front end 114.0 cm (44.8 in). The wheelbase on the left side was shortened by 32.0 cm (12.6 in).

**CDC:** 12FDEW4

<b>Delta V<sup>2</sup>:</b>	<b>Total</b>	73.6 km/h (45.7 mph)
	<b>Longitudinal</b>	-73.3 km/h (-45.5 mph)
	<b>Latitudinal</b>	-6.4 km/h (-4.0 mph)
	<b>Energy</b>	332,675 joules (245,368 ft lbs)

Six crush measurements were documented at the bumper level as follows: C1 = 109.0 cm (42.9 in), C2 = 77.0 cm (30.3 in), C3 = 45.0 cm (17.7 in), C4 = 44.0 cm (17.3 in), C5 = 37.0 cm (14.6 in), C6 = 31.0 cm (12.2 in).



**Figure 3.** Front left, Toyota Tacoma

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<sup>2</sup>Computed using Barrier option. Barrier Equivalent Speed only coded into the EDS. There was insufficient data on the second vehicle to calculate a vehicle to vehicle delta V.

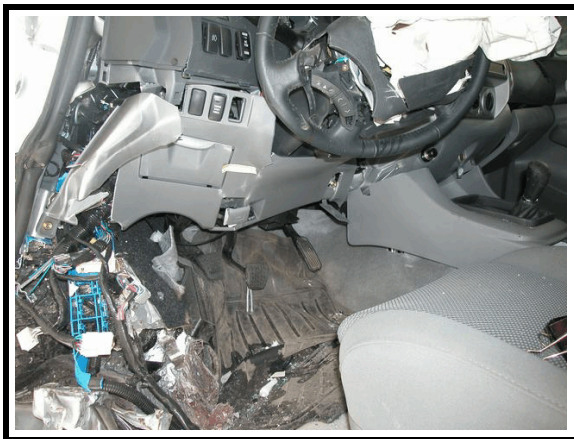


### Interior Damage - 2006 Toyota Tacoma

The 2006 Toyota Tacoma sustained moderate interior damage due to intrusion, occupant contacts, and extrication efforts. There was longitudinal intrusion to the driver's position through the toe pan, lower A pillar and the floor. The windshield was fractured in multiple locations due to damage. The driver's door had likely been jammed post-crash and was removed during extrication efforts. The front right door remained closed and operational. The steering wheel rim completely collapsed (8.0 cm [3.1 in] of movement) with the bottom portion of the rim pushed further forward than the top. The distance from the seat back to the top of the rim was 71.0 cm (27.9 in). The distance from the seat back to the bottom of the rim was 63.0 cm (24.8 in). The lower instrument panel/knee bolster was cracked and deformed—primarily on the left side from the driver's left knee.

### MANUAL RESTRAINT SYSTEMS - 2006 Toyota Tacoma

The 2006 Toyota Tacoma was configured with manual 3-point lap and shoulder belts for each outboard seat position and an manual lap belt in the second row middle seat position. Both front seat belts were equipped with retractor pretensioners and adjustable D rings that were adjusted to the full down positions. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). This safety belt was found in the pretensioned, stowed position and was not used during the crash. The remaining outboard safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).



**Figure 4.** Front left interior damage



**Figure 5.** D ring adjuster, driver's side

## Supplemental Restraint System - 2006 Toyota Tacoma

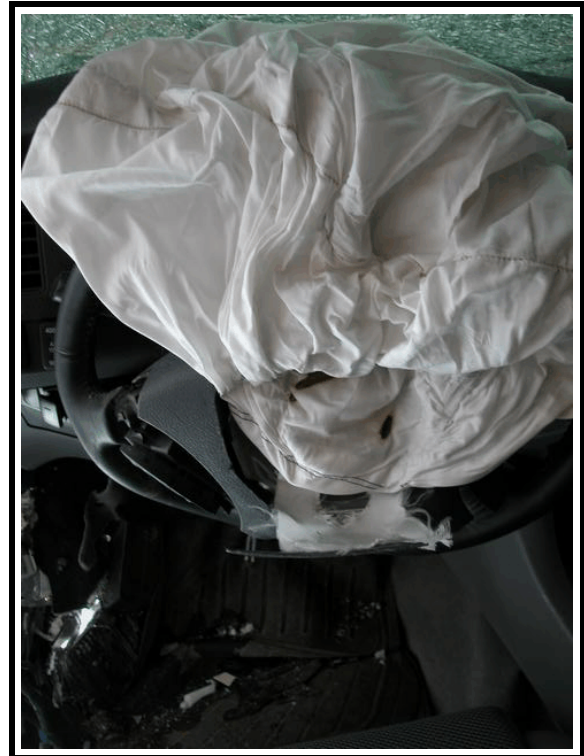
The 2006 Toyota Tacoma was equipped with dual stage frontal air bags and safety belt retractor pretensioners for the driver and front right passenger positions. The passenger air bag was controlled by a cut off switch that was in the AUTO position. The driver's air bag deployed and the driver's seat belt pretensioner actuated as a result of the longitudinal deceleration of the Tacoma during impact with the other pickup truck. The passenger air bag did not deploy.

The driver's air bag deployed from the center of the steering wheel hub through H-configuration module cover flaps. The upper flap measured 13.0 cm (5.1 in) at the bottom and 11.0 cm (4.3 in) on each side. The bottom flap measured 13.0 cm (5.1 in) at the top and 8.0 cm (3.1 in) on each side. At the time of the vehicle inspection, the top flap was found trapped behind the steering wheel rim. The deployed driver's air bag measured 60.0 cm (23.6 in) in diameter in its deflated state. The air bag was tethered by a single internal strap. Two circular vent ports were located at the 11 and 1 o'clock positions on the rear of the air bag. There was a 6.0 x 13.0 (2.4 x 5.1 in) hole in the right upper quadrant on the air bag face. There was a melted 5.0 cm (1.9 in) hole at the top right seam. Portions of the bottom center of the air bag were melted to the inflator face. The distance from the module to the seam on the top was 26.0 cm (10.2 in), but the measurement for the bottom was 15.0 cm (5.9 in). There were blood drops across the left side of the air bag face and blood/saliva drops on the bottom.

At impact with the Ford pickup the driver's air bag deployed. At the time of the vehicle inspection, the air bag was damaged by heat and was partially melted to the inflator. As a result, the air bag appears to have only partially deployed. It is possible that the air bag deployed fully and the burning/melting occurred as the air bag was overloaded by the driver. This would explain the damage near the inflator, but would not explain the burn/tears to the upper right seam. A more likely scenario is that the driver loaded the air bag while it was deploying and prevented a full inflation.



**Figure 6.** Face of driver's air bag



**Figure 7.** Air bag fabric melted to inflator



**Figure 8.** Burn/tear to upper right seam



**Figure 9.** Melted portion of air bag at inflator

**VEHICLE DATA - 1966 Ford F250**

Description:	1966 Ford F250 pickup truck	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Major front end damage. Towed from scene.	
CDC:	Unknown	
`Delta V:	Total	Unknown
	Longitudinal	Unknown
	Latitudinal	Unknown
	Energy	Unknown

**OCCUPANT DEMOGRAPHICS - 2006 Toyota Tacoma**

	Driver
Age/Sex:	22/Male
Seated Position:	Front left
Seat Type:	Cloth covered bucket seat. Seat adjusted to between full forward and mid position, 12.0 cm (4.7 in) rear of full forward position
Height:	170 cm (67 in)
Weight:	73 kg (160 lbs)
Occupation:	Unknown
Pre-existing Medical Condition:	None
Alcohol/Drug Involvement:	None, per autopsy
Driving Experience:	Unknown
Body Posture:	Upright
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, not used. Usage based on vehicle inspection.
Air bag:	Steering wheel mounted front air bag, deployed.

**OCCUPANT DEMOGRAPHICS - 1966 Ford F250**

	Driver	Occupant 2
Age/Sex:	52/Male	19/Male
Seated Position:	Front left	Front right
Seat Type:	Unknown	Unknown
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	Alcohol involvement, based on police observation	NA
Driving Experience:	Unknown	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	None available	None available

**OCCUPANT INJURIES -2006 Toyota Tacoma****Driver:** Injuries obtained from autopsy report.

<b><u>Injury</u></b>	<b><u>OIC Code</u></b>	<b><u>Injury Mechanism</u></b>	<b><u>Confidence Level</u></b>
Intraventricular laceration, right atrium	441300.5,4	Steering wheel rim	Probable
Contusions, lungs, bilateral	441410.4,3	Steering wheel rim	Probable
Multiple deep lacerations (major), liver	541826.4,1	Steering wheel rim	Probable
Lacerations (minor), spleen	544222.2,2	Steering wheel rim	Probable
Fracture, left patella (knee)	852400.2,2	Left instrument panel	Certain
Laceration into joint, left knee	850818.2,2	Left instrument panel	Certain
Abrasion, left eyelid	297202.1,2	Driver's air bag	Certain
Laceration, left eyelid	297602.1,2	Driver's air bag	Certain
Confluent lacerations, nose	290602.1,4	Driver's air bag	Certain
Laceration, lower lip	290602.1,8	Driver's air bag	Probable
Multiple lacerations, left cheek	290602.1,2	Driver's air bag	Certain
Multiple lacerations, chin	290602.1,8	Driver's air bag	Certain
Laceration, lower lip, left side	290602.1,8	Driver's air bag	Certain
Multiple abrasions, upper abdomen (epigastrium)	590202.1,7	Steering wheel rim	Probable
Multiple contusions, chest	490402.1,0	Steering wheel rim	Probable
Multiple contusions, upper abdomen	590402.1,7	Steering wheel rim	Probable
Multiple contusions, abdomen, lower left	590402.1,2	Steering wheel rim	Probable
Contusion, left upper arm	790402.1,2	Unknown	Unknown

Laceration, left hand	790602.1,2	Left instrument panel	Possible
Abrasion, left wrist	790202.1,2	Unknown	Unknown
Abrasion, left lower leg	890202.1,2	Left instrument panel	Possible
Multiple contusions, right leg	890402.1,1	Left instrument panel	Possible
Multiple abrasions, right leg	890202.1,1	Left instrument panel	Possible
Multiple abrasions, right hand	790202.1,1	Unknown	Unknown
Multiple contusions, left thigh	890402.1,2	Steering wheel rim	Probable
Multiple contusions, left lower leg	890402.1,2	Left instrument panel	Possible

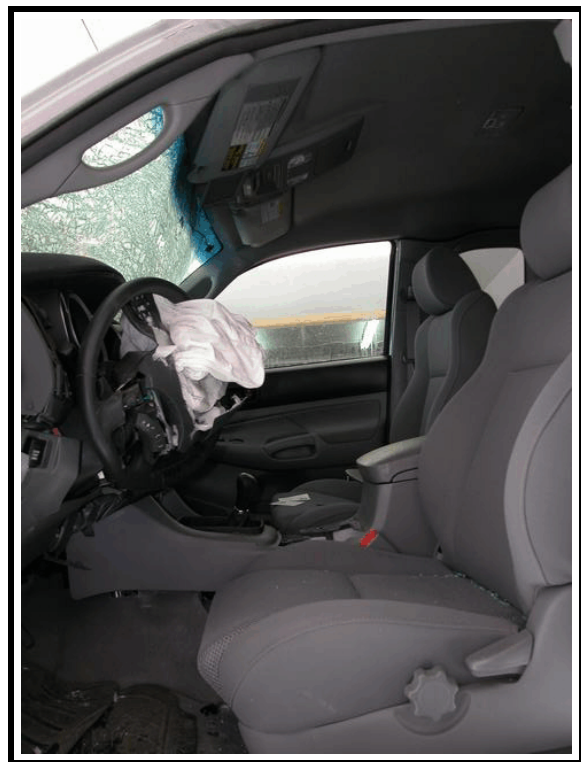


## OCCUPANT KINEMATICS - 2006 Toyota Tacoma

The 22 year old male driver was seated in an upright posture. He was not wearing the manual lap and shoulder belt. The seat track was positioned between the fully forward and mid position—12.0 cm (4.7 in) rear of the fully forward position. At impact, the driver's air bag deployed and the safety belt pretensioner actuated. The safety belt was not in use. The male driver initiated a forward trajectory and engaged the air bag with his chest and face. He loaded and collapsed the steering wheel rim—causing lacerations of the right atrium, liver, and spleen; bilateral lung contusions; contusions to the anterior chest, upper abdomen, and left lower abdomen; hemothorax and hemoperitoneum. The driver continued forward in a submarining fashion and engaged the left lower instrument panel with his left knee—causing a fracture and dislocation of the patella—and with his right knee/lower leg—causing scattered contusions and abrasions. According to the autopsy report, he also sustained small superficial lacerations to the left eyelid, tip of the nose, and lower lip. He was pronounced dead at 0950 hours; approximately one hour post-crash.



**Figure 10.** Distance from SW rim to seat back



**Figure 11.** Driver's seated area

**Attachment 1. Scene Diagram**

