Side Curtain Air Bag Investigation
Dynamic Science, Inc. (DSI), Case Number DS08022
2006 Subaru B9 Tribeca
Nebraska
May 2008

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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 deployment of the side curtain and seat mounted side air bags in a 2006 Subaru Tribeca that was involved in a three vehicle crash. The Tribeca was being driven by a restrained 27-year-old female. The Tribeca was struck on the left side by a 2003 Chevrolet Tahoe sport utility vehicle. The impact resulted in sufficient lateral deceleration of the Subaru to command the deployment of the left side curtain air bag and left seat mounted air bag. After the initial impact, the Subaru was deflected laterally to the right across the intersection and contacted a 1999 Mercedes-Benz E430 four-door sedan. There were no reported injuries. The Subaru was towed from the scene due to damage and was later to be declared a total loss by the insurance company. The Chevrolet was towed from the scene and was not available for an inspection. The Mercedes was driven from the scene.

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BACKGROUND

Figure 1. Damaged 2006 Subaru Tribeca

This on-site investigation focused on the deployment of the side curtain and seat mounted side air bags in a 2006 Subaru Tribeca that was involved in a three vehicle crash (**Figure 1**). The Tribeca was being driven by a restrained 27-year-old female. The front right seat was occupied by a 28-year-old female. The Tribeca was struck on the left side by a 2003 Chevrolet Tahoe sport utility vehicle. The impact resulted in sufficient lateral deceleration of the Subaru to command the deployment of the left side curtain air bag and left seat mounted side air bag. After the initial impact, the Subaru was deflected laterally to the right across the intersection and contacted a 1999 Mercedes-Benz E430 four-door sedan. There were no reported injuries. The Subaru was towed from the scene due to damage and was later declared to be a total loss by the insurance company. The Chevrolet was towed from the scene and was not available for an inspection. The Mercedes was driven from the scene.

This crash was identified by the National Highway Traffic Safety Administration (NHTSA) during a review of General Estimates System (GES) police reports. On July 3, 2008, DSI was sent a copy of the police report and instructed to obtain permission to inspect the subject vehicle, a 2006 Subaru Tribeca sport utility vehicle. On July 9, 2008, DSI located the vehicle at an auto salvage facility and obtained permission to conduct the inspection. The case number was assigned on July 10, 2008 and the field work was completed on July 17, 2008.

SUMMARY

Crash Site

Figure 2. Westbound approach for the Subaru Tribeca

This crash occurred at a four-leg intersection in May 2008 at 2115 hours. At the time of the crash, there were no adverse weather conditions and the concrete roadways were dry. The roadways were dark and the streetlights were on. The intersection was controlled by traffic signals at each leg. The westbound leg of the intersection was comprised of two westbound travel lanes, a left hand turn lane, and two eastbound travel lanes. There was a right curve approaching the intersection (**Figure 2**). The eastbound leg of the intersection was comprised of a right turn lane, two eastbound travel lanes, a left turn lane, and three westbound travel lanes (**Figure 3**). The left turn lane was separated from the westbound travel lanes by a raised median. The southbound leg of the intersection was comprised of a right turn lane, a southbound lane, a left turn lane, and a single northbound lane (**Figure 4**). The speed limit was 64 kmph (40 mph) for all the involved roadways.

Pre Crash

The Subaru Tribeca was traveling west in the second lane from the right and was approaching the intersection. A 2003 Chevrolet Tahoe truck was being driven east by a restrained 29-year-old male and had come to a stop in the left turn lane. A 1999 Mercedes E430 four-door sedan was being driven south by a 48-year-old female and had come to a stop at the intersection. As the Tribeca entered the intersection, the Tahoe began a left turn to the north.

Figure 3. Eastbound approach for the Chevrolet Tahoe

Crash

The driver of the Tribeca steered her vehicle to the right, but the front of the Tahoe struck the left side of the Tribeca. The seat mounted side air bag and the side curtain air bag deployed at impact. The Missing Vehicle algorithm of the WinSmash program computed a total delta V of 21.0 km/h (13.0 mph), based on the Tribeca's left side crush profile. The longitudinal and lateral components were -13.5 km/h (-8.4 mph) and 16.1 km/h (10.0 mph), respectively. After the initial impact, the Tribeca began a counterclockwise rotation, traveled in a northwest direction across the intersection, and struck the left side of the Mercedes.

Figure 4. Southbound approach for the Mercedes E430

Post Crash

There were no injuries reported. The Tribeca was towed from the scene and was later declared to be a total loss by the insurance company. The Tahoe was towed from the scene to an undisclosed location. The Mercedes was driven from the scene.

Vehicle Data - 2006 Subaru B9 Tribeca

The 2006 Subaru Tribeca was identified by the Vehicle Identification Number (VIN): 4S4WX82C064xxxxxx. The date of manufacture was October 2005. The vehicle's odometer could not be read because there was no power to the vehicle. The Tribeca was a 4-door, 5-passenger sport utility vehicle that was equipped with a 3.0 liter, 6-cylinder engine, a 5-speed automatic transmission, front/rear anti-lock disc brakes, vehicle dynamics control (VDC), power steering, and a tilt steering wheel. The Tribeca was configured with Goodyear Eagle P255/55R18 tires. The vehicle manufacturer's recommended cold tire pressure was 221 kPa (32 psi); the tire manufacturer's stated maximum pressure was 303 kPa (44 psi).

The specific tire information was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	276 kPa (40 psi)	10 mm (12/32 in)	No	None
LR	Tire Flat	7 mm (9/32 in)	No	Sidewall and tread holed
RR	248 kPa (36 psi)	9 mm (11/32 in)	No	None
RF	290 kPa (42 psi)	6 mm (7/32 in)	No	None

The left rear tire was torn during the crash (**Figure 5**). There was a T-shaped tear that began in the sidewall and extended to the outboard portion of the tread. The base of the "T" measured 11 cm (4.3 in) in a diagonal direction. The left portion of the "T" measured 19 cm (7.5 in) and the right portion measured 5 cm (2.0 in). There was also a 12 cm (4.7 in) long tear in the tread. The tear was diagonal and began 4 cm (1.6 in) from the side wall and terminated 2 cm (0.8 in) from the sidewall.

Figure 5. Damaged left rear tire

The seating in the Subaru Tribeca was configured with front bucket seats with active head restraints and a rear 40/20/40 split back bench seat. The front seat head restraints are designed to automatically tilt forward in the event of a rear impact thereby decreasing the amount of rearward head movement. The driver's seat was located in the mid track position. The seat back was at a 19 degree angle from vertical and the seat cushion was at an 18 degree angle from horizontal.

Vehicle Damage

Exterior Damage - 2006 Subaru B9 Tribeca

The 2006 Subaru Tribeca sustained moderate left side plane damage from the impact with the Chevrolet pickup (**Figure 6**). The direct damage began 68 cm (26.8 in) aft of the front axle and extended 254 cm (100 in) rearward along the left side plane. The height of the maximum door crush was 63 cm (24.8 in) from the ground and was located near the trailing edge of the left rear door. The left rear door was jammed shut.

Figure 6. Left side damage, Subaru Tribeca

The suspension trailing arm for the left rear wheel was fractured and separated at the wheel from impact with the pickup. At the time of the inspection, the wheel/tire had a positive camber of approximately 45 degrees. The left rear bumper fascia was dislodged and tilted downward. The combined direct and induced damage began 65 cm (25.6 in) aft of the front axle and extended 265 cm (104.3 in) rearward along the left side plane. Six crush measurements were documented at the mid-door level as follows: C1 = 0 cm, C2 = 9 cm (3.5 in), C3 = 18 cm (7.0 in), C4 = 15 cm (5.9 in), C5 = 6 cm (2.4 in), C6 = 0 cm. The maximum lateral crush was located at C3 and was 61 cm (24.0 in) above the ground. The Collision Deformation Classification (CDC) for the impact with the pickup was 10LZEW2.

Figure 7. Light scratches to left bumper corner and area below tail light

The police report stated that the right rear of the Subaru contacted the left side of the Mercedes after the initial impact with the Chevrolet pickup. There were no indications of damage on the right rear corner. There were, however, several light scratches located at the left rear bumper corner and below the left tail light that seem consistent with the impact. The CDC for this second event was 06BLEE1.

Figure 8. Left lower door intrusion

Interior Damage - 2006 Subaru B9 Tribeca

The 2006 Subaru Tribeca sustained minor interior damage as a result of passenger compartment intrusion (**Figure 8**). The lower leading edge and the rear upper quadrant of the left rear door and left A-pillar sustained lateral intrusion. As a result of the lateral intrusion, the inboard area of the left rear door was pressed against the second row seat cushion

The specific passenger compartment intrusions were documented as follows:

Position	**Intruded Component**	**Magnitude of Intrusion**	**Direction**
Second row left	Door/Rear upper quadrant	9 cm (3.5 in)	Lateral
Front row left	A-pillar	4 cm (1.6 in)	Lateral

Manual Restraints - 2006 Subaru B9 Tribeca

The 2006 Subaru Tribeca 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 down position. The driver's safety belt was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). At the time of the vehicle inspection, the driver's retractor was restricted in the used position as a result of pretensioner actuation (**Figure 9**). A 6.5 cm (2.6 in) linear plastic transfer from the plastic-covered latch plate was located 61 cm (24.0 in) above the anchor and extended across the entire width of the webbing. There was an area of abrasion located in the belt path of the latch plate (**Figure 10**). The abrasion extended across the entire width of the belt path.

Figure 9. Driver's belt restricted in used position

Figure 10. Loading to driver's seat belt latch

The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR). The retractor for the second row middle seat was located in the roof. The front right safety belt was restricted in the stowed position at the time of inspection as a result of pretensioner actuation.

Supplemental Restraint Systems - 2006 Subaru B9 Tribeca

The Subaru Tribeca was equipped with advanced occupant protection systems including multi-stage Certified Advanced 208-Compliant driver and front right passenger air bags. The multi-stage air bags were certified by the manufacturer to meet the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The frontal air bags did not deploy.

The Tribeca was also equipped with side curtain air bags and seat mounted side air bags. The left side curtain and left seat mounted air bags deployed as a result of the impact with the pickup truck (**Figures 11-12**). The right side air bags did not deploy. The curtain air bags included curtain air bag modules in the roof rail behind the C-pillars and sensors located forward of the rear wheels.

The seat mounted side air bags included the module in the seat back and a side air bag sensor located in the B-pillar. The curtain air bags and side air bags were not controlled by the Subaru's advanced frontal air bag system

The left side curtain air bag deployed vertically from roof cladding. The curtain measured 166 cm (65.3 in) in length and 47 cm (18.5 in) in height. It provided coverage for both the first and second rows of the vehicle. The curtain was attached to the left A-pillar by a 3 cm (1.2 in) tether. The forward portion of the curtain was comprised of a single piece of nylon cloth that measured 28 cm (11.0 in) in width and 31 cm (12.2 in) in height. The rear of the curtain was secured to the vehicle by a fabric tether that was located in the roof just aft of the C-pillar. There were no indications of damage or contact to the curtain.

The left side air bag deployed longitudinally from the driver's seat back. The deployed air bag measured 32 cm (12.6 in) wide by 59 cm (23.2 in) high in its deflated state. The air bag was generally oval in shape. There were a set of three 0.5 cm (0.2 in) vent ports on both the outboard and inboard aspect of the air bag. There was one 2 cm (0.8 in) circular vent port located on the leading edge of the outboard aspect of the air bag. There were no indications of damage or contact to the side air bag.

Figure 11. Exterior view, side air bags

Figure 12. Interior view, side air bags

OCCUPANT DEMOGRAPHICS - 2006 Subaru B9 Tribeca

	Driver	**Front Right Passenger**
Age/Sex:	27/Female	28/Female
Seated Position:	Front left	Front right
Seat Type:	Bucket	Bucket
Height:	168 cm (66 in)	Unknown
Weight:	64 kg (140 lbs)	Unknown
Alcohol/Drug Involvement:	None	None
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, actively steering to right	Unknown
Foot Position:	Right foot on brake, left on floorboard	Both on floorboard
Restraint Usage:	Lap and shoulder belt used	Lap and shoulder belt available, not used
Air bag:	Driver's frontal air bag available, did not deploy. Side curtain and side air bag available, deployed.	Front right passenger air bag, side curtain air bag, seat mounted side air bag available, did not deploy.

OCCUPANT KINEMATICS - 2006 Subaru B9 Tribeca

Driver Kinematics

The 27-year-old female 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 mid track position. The seat back was positioned 19 degrees from vertical and the seat cushion was positioned 18 degrees from horizontal. Prior to impact, the driver was actively steering to the right and was braking. At impact, the left side curtain air bag and the seat mounted side air bag deployed and the safety belt pretensioner actuated. The female driver initiated a lateral and slightly forward trajectory to the left in response to the10 o'clock direction of force. She loaded the safety belt and likely contacted the deployed curtain air bag and side air bag, although no physical evidence of contact was identified. The vehicle rotated in a counterclockwise direction and the driver was likely displaced to the right. The rear of the subject vehicle struck the stopped Mercedes, but this was a minor impact that would have had a negligible effect on the driver. The driver came to rest in her original seating position. She did not sustain any injuries and was able to exit the vehicle under her own power.

Front Right Occupant Kinematics

The 28-year-old female front right occupant was seated in an upright posture and was not restrained by the 3-point manual lap and shoulder belt. Prior to impact, the driver was actively steering to the right and was braking. This occupant was displaced in a forward direction due to braking. At impact, this occupant initiated a lateral and slightly forward trajectory to the left. The vehicle rotated in a counterclockwise direction and the this occupant was likely displaced somewhat to the right. The rear of the subject vehicle struck the stopped Mercedes, but this was a minor impact that would have had a negligible effect on the this occupant. The front right occupant came to rest in her original seating position. She did not sustain any injuries and was able to exit the vehicle under her own power.

OCCUPANT INJURIES - 2006 Subaru B9 Tribeca

Driver: No injuries

Front Right Passenger: No injuries.

Attachment 1. Scene Diagram