

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE
CRASH INVESTIGATION**

SCI CASE NO: CA08029

LOCATION: NEW YORK

VEHICLE: 2007 SUBARU LEGACY

CRASH DATE: JULY 2008

Contract No. DTNH22-07-C-00043

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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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16. Abstract This on-site investigation focused on the Certified Advanced 208-Compliant (CAC) safety system in 2007 Subaru Legacy and the resultant injuries to an unrestrained 55-year-old female driver. The manufacturer of this vehicle has certified that the Legacy is compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard No. 208. The Subaru's CAC system consisted of dual stage frontal air bags, seat track position sensors, safety belt buckle switch sensors, retractor mounted safety belt pretensioners for the front seats, and an occupant weight sensor for the front right seat. In addition to the CAC system, the Subaru was equipped with seat back mounted side impact air bags and curtain air bags for the outboard seating positions. The Subaru was involved in a head-on frontal collision with a 2006 Lexus GX 470. As a result of the crash the driver's frontal air bag deployed in the Subaru. The driver of the Subaru sustained fatal injuries and was pronounced deceased 27 minutes post-crash. The Lexus was also equipped with a CAC frontal air bag system, retractor mounted safety belt pretensioners for the front seats, seat back mounted side impact air bags, and curtain air bags for the outboard seating positions. The Lexus was occupied by a restrained 39-year-old female driver, a 6-year-old male rear left passenger positioned in a backless booster seat; and restrained by the lap and shoulder belt, and a restrained 9-year-old rear right passenger. The driver's frontal air bag and the right curtain air bag deployed and the driver's retractor pretensioner actuated in the Lexus. The driver and child passengers of the Lexus sustained moderate severity injuries and were transported to a hospital where they were treated and released.					
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SCI CASE NO: CA08029
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CRASH DATE: JULY 2008**

BACKGROUND

This on-site investigation focused on the Certified Advanced 208-Compliant (CAC) safety system in 2007 Subaru Legacy (**Figure 1**) and the resultant injuries to an unrestrained 55-year-old female driver. The manufacturer of this vehicle has certified that the Legacy is compliant to the Advanced Air Bag portion of Federal Motor Vehicle Safety Standard No. 208. The Subaru's CAC system consisted of dual stage frontal air bags, seat track position sensors, safety belt buckle switch sensors, retractor mounted safety belt pretensioners for the front seats, and an occupant weight sensor for the front right seat. In addition to the CAC system, the Subaru was equipped with seat back mounted side impact air bags and curtain air bags for the outboard seating positions. The Subaru was involved in a head-on frontal collision with a 2006 Lexus GX 470. As a result of the crash the driver's frontal air bag deployed in the Subaru. The driver of the Subaru sustained fatal injuries and was pronounced deceased 27 minutes post-crash.



Figure 1. 2007 Subaru Legacy.

The Lexus was also equipped with a CAC frontal air bag system, retractor mounted safety belt pretensioners for the front seats, seat back mounted side impact air bags, and curtain air bags for the outboard seating positions. The Lexus was occupied by a restrained 39-year-old female driver, a 6-year-old male rear left passenger positioned in a backless booster seat; and restrained by the lap and shoulder belt, and a restrained 9-year-old rear right passenger. The driver's frontal air bag and the right curtain air bag deployed and the driver's retractor pretensioner actuated in the Lexus. The driver and child passengers of the Lexus sustained moderate severity injuries and were transported to a hospital where they were treated and released.

This crash was identified by the National Highway Traffic Safety Administration (NHTSA) through an Internet news article that was forwarded to the Calspan Special Crash Investigations (SCI) team for follow-up investigation on July 30, 2008. The Subaru and the Lexus were located and cooperation was established with the impound yard to inspect the vehicles. An on-site investigation was assigned to the Calspan SCI team on July 30, 2008. The vehicle's and crash site inspections were conducted on August 5, 2008.

SUMMARY

Crash Site

This crash occurred in the westbound lane of a two-lane east/west roadway in a residential area during the daytime hours of July 2008. The travel lanes were surfaced with asphalt and were dry at the time of the crash. The east and westbound lanes measured 3 meters (9.8') and 2.7 meters (8.8'), respectively. A right curve was present for the eastbound travel direction. The travel lanes were bordered by white fog lines. Narrow asphalt shoulders extended beyond the fog lines. Additionally, mountable concrete curbs were located outboard of the shoulders. Private driveways intersected the east/west roadway. The posted speed limit was 48 km/h (30 mph).

Vehicle Data – 2007 Subaru Legacy

The case vehicle in this crash was a 2007 Subaru Legacy Outback L.L. Bean Edition station wagon. The Subaru was manufactured in 10/06 and was identified by Vehicle Identification Number (VIN) 4S4BP86C774 (production number deleted). The vehicle was powered by a 3.0-liter, six-cylinder engine linked to a five-speed automatic transmission with a console mounted shift lever and all-wheel drive. The service brakes were power-assisted front and rear disc with antilock and electronic brake force distribution. The Subaru was equipped with traction control and a Tire Pressure Monitoring System (TPMS). The tires were Bridgestone Potenza, size P225/55R17, mounted on OEM five-spoke alloy wheels. The vehicle manufacturer recommended cold front and rear tire pressure was 221 kPa (32 PSI) front and 207 kPa (30 PSI) rear. The tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	262 kPa (38 PSI)	6 mm (7/32")	None
Right Front	Tire Flat	6 mm (7/32")	Punctured tread
Left Rear	248 kPa (36 PSI)	6 mm (7/32")	None
Right Rear	186 kPa (27 PSI)	6 mm (7/32")	None

The interior of the Subaru was configured for five-passenger seating with front bucket seats and a rear bench with split folding backs. The five seating positions were equipped with adjustable head restraints. The front head restraints were adjusted to 9 cm (3.5") above the full-down position. The left rear head restraint was adjusted to 5 cm (2") above the full-down position and the center and right head restraints were adjusted to 6 cm (2.4") and 4 cm (1.6") above the full-down position. The vehicle was equipped with power windows, power door locks, and a tilt steering column. The safety systems consisted of the frontal CAC air bags, seat back mounted side impact air bags, curtain air bags, front safety belt pretensioners, and active front head restraints.

Vehicle Data – 2006 Lexus GX 470

The other vehicle in this crash was a 2006 Lexus GX 470 sport utility vehicle (**Figure 2**). The Lexus was manufactured in 01/06 and was identified by VIN: JTJBT20XX60 (production number deleted). The Lexus was powered by a 4.7-liter, eight-cylinder engine linked to a five-speed automatic transmission with a console mounted shift lever. The braking system consisted of power-assisted front and rear disc with antilock, brake assist, and electronic brake force distribution. The standard features also included a TPMS, traction control, and electronic stability control. The tires were Dunlop AT20 Grand Trek, size P265/65R17, mounted on OEM five-spoke alloy wheels. The vehicle manufacturer recommended cold tire pressure was 221 kPa (32 PSI) for the front and rear. The tire data at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	255 kPa (37 PSI)	6 mm (8/32")	None
Right Front	Tire Flat	6 mm (8/32")	Cut sidewall
Left Rear	255 kPa (37 PSI)	6 mm (8/32")	None
Right Rear	262kPa (38 PSI)	6 mm (7/32")	None

The interior of the Lexus was configured for eight-passenger seating. The first row consisted of bucket seats with height adjustable head restraints that were adjusted to the full-down positions. Mounted to the rear aspects of the front head restraints were DVD monitors. The second row seating was a 60/40 split bench with height adjustable head restraints for all three positions. These head restraints were adjusted to the full-down position. The Lexus was also equipped with a third row designed for use of up to three passengers. The seat type was a split bench 60/40 left side wide. These seats could be folded up and against the side panels for storage. At the time of the SCI inspection, the third row seat was located folded in the stored position. In addition to the CAC frontal air bag system, the vehicle was equipped with seat back mounted side impact air bags, rollover sensing curtain air bags, and retractor mounted safety belt pretensioners for the front seats. **Figure 2** is an overall view of the involved vehicles.



Figure 2. Overall view of the Subaru and the Lexus.

Crash Sequence

Pre-Crash

The 55-year old female driver of the 2007 Subaru was operating the vehicle in an easterly direction on the two-lane roadway. The vehicle entered a 90 meter (295') long right curve during its eastbound travel. As the vehicle neared the end of the right curve, the driver allowed the Subaru to cross the double yellow centerline and enter the westbound travel lane (**Figure 3**). The driver's autopsy revealed that her post-mortem Blood Alcohol Content (BAC) measured 0.39.

The 39-year-old female driver of the Lexus was operating her vehicle westbound approaching the curved section of the roadway (**Figure 4**). In the westbound direction, the roadway curved left. The driver of the Lexus observed the Subaru in the westbound lane as she neared the left curve. The driver of the Lexus applied a left steering input in an effort to avoid the Subaru. The Scene Schematic is included as **Figure 17** of this report.



Figure 3. Eastbound approach of the Subaru.



Figure 4. Westbound approach of the Lexus.

Crash

The full frontal aspect of the Subaru impacted the front of the Lexus within the westbound lane. The impact configuration was slightly off-set right for both vehicles. The resultant directions of force were within the 12 o'clock sector for the Subaru and the Lexus. Due to the slight off-set impact configuration, the vehicles rotated clockwise. The Subaru continued its eastbound trajectory and came to rest off the south roadside facing a westerly direction approximately 5.5 meters (18') from the point of impact. The Lexus traveled approximately 7.5 meters (25') and came to rest on the north roadside facing easterly.

A delta-V analysis was completed using the WINSMASH program. The total computed delta-V for the Subaru was 77 km/h (47.9 mph). The longitudinal and lateral components were -77 km/h (-47.9 mph) and 0 km/h, respectively. The total delta-V for the Lexus was 56 km/h (34.8 mph). The longitudinal component was -55.1 km/h (34.2 mph) with a lateral component of 10 km/h (6.0 mph).

The impact actuated the driver's retractor pretensioner and deployed the driver's frontal air bag in the Subaru. The driver's frontal air bag and the right curtain air bag deployed and the driver's retractor pretensioner actuated in the Lexus.

Post-Crash

Police and emergency personnel responded to the crash site. The driver of the Subaru was extricated from the vehicle and was transported to a local hospital where she was pronounced deceased 27 minutes post-crash. The driver and second row child passengers of the Lexus were transported to a local hospital where they were treated and released 8-9 hours post-crash. Both vehicles sustained severe frontal damage and were towed to a police impound yard.

Vehicle Damage

Exterior – 2007 Subaru Legacy

The 2007 Subaru sustained severe frontal damage as a result of the impact with the Lexus (**Figures 5 and 6**). The damaged components included but were not limited to the bumper fascia, bumper beam, hood, fenders, right front door, and the front wheels and suspension components. Additionally, the left and right wheelbases were reduced 7 cm (2.8") and 32 cm (12.6"), respectively. The impact was slightly off-set to the right; therefore, the maximum damage occurred to the right aspect of the frontal plane. The direct contact damage measured 140 cm (55") and extended from the left bumper corner to the right bumper corner. The maximum crush measured 85 cm (33.5") and was located 41 cm (16") inboard of the right bumper beam corner. A crush profile was documented along the 102 cm (40.2") bumper beam and was as follows: C1 = 51 cm (20"), C2 = 62 cm (24.4"), C3 = 68 cm (26.7"), C4 = 85 cm (33.5"), C5 = 84 cm (33"), C6 = 75 cm (29.5"). The Collision Deformation Classification (CDC) for this impact was 12-FDEW-4.



Figure 5. Overall view of the frontal damage to the Subaru.



Figure 6. Overhead view of the resultant crush to the Subaru.

All four doors remained closed during the crash. Post-crash, the left front and right side doors were jammed shut and the left rear door remained operational. The windshield was fractured and the left and right front door glazing was disintegrated. The remaining side, rear, and roof glazing were intact.

Interior – 2007 Subaru Legacy

The interior of the Subaru sustained severe damage due to a combination of passenger compartment intrusion and driver contact. **Figure 7** is a view of the driver's area. The driver's contact points consisted of loading of the steering wheel, knee bolster, windshield, and sun visor. During this loading, the steering wheel flange fractured (**Figure 8**) separating the steering wheel from the column. The steering rim was displaced forward resulting in a 1 cm (0.4") gap at the 3 and 9 o'clock spokes and 3 cm (1.2") at the 6 o'clock spoke. Additionally, the steering wheel rim was deformed upward 4 cm (1.6") at the 7 o'clock location. There was 2 cm (0.8") of compression to the left and right sheer capsules. The knee bolster exhibited deformation from contact with both of the driver's knees. The left contact occurred to the left end of the knee bolster on the fuse box access door. The right knee contact was located on the right end of the bolster at the junction with the center console. A contact point was noted to the windshield forward and below the steering wheel rim. This contact was attributed to the driver's right hand and was evidenced by the fractured glass and tissue transfers. The driver's head contacted the sun visor which resulted fractured the mirror mounted within the sun visor. Also noted was that the rear view mirror was displaced from its windshield mount and the glass was fractured. This contact was attributed to the driver's right hand.



Figure 7. View of the driver's area.



Figure 8. Fractured steering wheel flange.

The passenger compartment intrusions are listed in the table below:

Location	Component	Magnitude	Direction
Front Left	Instrument panel	3 cm (1.2")	Longitudinal
Front Left	Toe pan	8 cm (3.2")	Longitudinal
Front Center	Instrument panel	3 cm (1.2")	Longitudinal
Front Center	Floor/transmission tunnel	5 cm (2")	Lateral
Front Center	Center stack	13 cm (5.1")	Longitudinal
Front Right	Instrument panel	9 cm (3.5")	Longitudinal
Front Right	Toe pan	19 cm (7.5")	Longitudinal
Front Right	Floor/transmission tunnel	5 cm (2")	Lateral

Exterior – 2006 Lexus GX 470

The 2006 Lexus GX 470 sustained severe damage to the front and right planes as a result of the impact with the Subaru (**Figure 9**). The damage consisted of longitudinal crush to the frontal plane. The direct contact damage from this off-set right impact began 24 cm (9.5”) left of the centerline and extended 76 cm (29.9”) to the right bumper corner. The maximum crush occurred at the right corner of the bumper beam and measured 72 cm (28.3”). A crush profile was documented along the bumper beam which was as follows: C1 = 0 cm, C2 = 0 cm, C3 = 59 cm (23.2”), C4 = 59 cm (23.2”), C5 = 56 cm (22”), C6 = 72 cm (28.3”). The CDC assigned for this impact was 12-FZEW-3.



Figure 9. Resultant frontal damage to the Lexus.

The right front door was restricted in the closed position post-crash due to body deformation. The remainder of the doors were closed and operational. The windshield was fractured and the right front door glazing was disintegrated during the crash. No damage occurred to the remainder of the vehicle glazing.

Interior – 2006 Lexus GX470

The interior of the Lexus sustained moderate severity damage from a combination of passenger compartment intrusion and occupant contact points. The occupant contact points consisted of deformation to the left knee bolster by the driver’s knees, fractured windshield from contact with the driver’s right hand, displaced rearview mirror by the driver’s right hand, and compression of the steering column. The steering column compression resulted in approximately 1 cm (0.4”) of sheer capsule displacement. Occupant contact points from the rear passengers were not evident. **Figures 10 and 11** are overall views of the first and second rows. Safety belt loading evidence was present on the belt webbings for the three occupied positions. This loading is discussed the Manual Restraints section of this report.



Figure 10. View of the front row of the Lexus.



Figure 11. Overall view of the second row of the Lexus.

The passenger compartment intrusions are listed in the table below:

Location	Component	Magnitude	Direction
Front Right	Instrument panel	3 cm (1.2")	Longitudinal
Front Right	Toe Pan	10 cm (3.9")	Longitudinal
Front Right	Side panel forward of A-pillar	10 cm (3.8")	Lateral
Front Right	Sill	12 cm (4.7")	Lateral

Certified Advanced 208-Compliant Frontal Air Bag System

2007 Subaru Legacy

The 2007 Subaru was equipped with a Certified Advanced 208-Compliant (CAC) frontal air bag system for the driver and front right passenger positions. This system consisted of dual-stage air bags, seat track position sensors, safety belt buckle switch sensors, a front right passenger weight sensor, and front safety belt retractor pretensioners.

The driver's air bag was concealed within the center hub of the three-spoke steering wheel by asymmetrical cover flaps. The top flap was 12 cm (4.7") in width at the horizontal tear seam and 9 cm (3.5") in height. The two lower flaps were 7 cm (2.8") in width and height. The air bag membrane was 59 cm (23.2") in diameter in its deflated state and was tethered internally by two straps at the 11 and 1 o'clock positions. The air bag was vented by two ports. The maximum excursion of the air bag (deflated) was 26 cm (10.2").

The air bag membrane contained numerous cuts and body fluid transfers. The largest area of body fluid was located on the rear panel at the 6 o'clock position and measured 31 x 22 cm (12.2 x 8.7"), height x width. Dirt was also present within this body fluid transfer. A second area of body fluid was located at the 11 o'clock sector and measured 12 cm (4.7") in height and 8 cm (3.2") in width. Body fluid was noted at the 5 o'clock position. This transfer measured 10 cm (3.9") in height and 11 cm (4.3") in width. Numerous small cuts that were approximately 0.8 cm (0.3") in size were present on the face of the membrane. These small cuts appeared to have occurred from shattered glass. Two larger cuts were noted on the membrane at the 12 and 1 o'clock positions. These cuts measured 3 cm (1.2") and 4 cm (1.6"), respectively. A 2 cm (0.8") cut was noted along the sewn perimeter seam at the 5 o'clock sector. **Figure 12** depicts the body fluid transfers and **Figure 13** shows the deployed air bag.



Figure 12. Body fluid transfers on the driver's air bag membrane.



Figure 13. Deployed driver's frontal air bag.

The front right air bag was a top mount design incorporated into the instrument panel. The front right seat was not occupied during the crash; therefore, the CAC system suppressed the deployment of the air bag.

Side Impact Air Bag System – 2007 Subaru Legacy

The Subaru was equipped with front seat back mounted side impact air bags and roof side rail mounted curtain air bags. These air bags did not deploy during the crash.

Certified Advanced 208-Compliant Frontal Air Bag System 2006 Lexus GX 470

The 2006 Lexus GX 470 was equipped with a CAC frontal air bag system for the driver and front right passenger positions. This system consisted of dual-stage air bags, seat track position sensors, safety belt buckle switch sensors, a front right passenger weight sensor, and front safety belt retractor pretensioners.

During the frontal crash, the driver's frontal air bag deployed (**Figure 14**). The driver's air bag was conventionally mounted in the center hub of the four-spoke steering wheel. The air bag module contained two symmetrical cover flaps that measured 8 cm (3.2") in height and 13 cm (5.1") in width. The air bag membrane was 57 cm (22.4") in diameter in its deflated state and was tethered internally by two straps. The air bag was vented by two ports located at the 11 and 1 o'clock positions. The maximum excursion of the air bag was 33 cm (13").



The driver's face contacted the air bag membrane, which was evidenced by a make-up transfer. The transfer was reddish colored and was located on the face of the air bag 9 cm (3.5") left of the centerline to 6 cm (2.4") right and 10 cm (3.9") above the center to 4 cm (1.6") below. Located within this transfer was a small area of body fluid. Body fluid was also present on the top rear panel and lower right rear panel of the membrane.

The front right air bag was located with the right instrument panel. This air bag did not deploy during the crash.

Side Impact Air Bag System – 2006 Lexus GX 470

The Lexus GX 470 was equipped with front seat back mounted side impact air bags and roof side rail mounted curtain air bags with rollover sensing. The left curtain air bag and the left and right seat back air bags did not deploy in this crash. The right curtain air bag deployed during crash sequence.

The right curtain air bag deployed from the roof side rail (**Figure 15**). The air bag membrane measured 216 cm (85") in length. At the front seating position, the membrane measured 55 cm (21.7") in height and 51 cm (20") in height at the right rear position.

The height at the third row was 42 cm (16.5"). The air bag was tethered at the A- and D-pillars. The A-pillar tether measured 12 cm (4.7") and the D-pillar tether measured 6 cm (2.4").

Vertically, the curtain air bag extended below the beltline at the first and second rows. At the third row, the curtain air bag did not span the complete vertical and longitudinal area of the third row glazing. A triangular shaped void was present at the third row glazing area (**Figure 16**). This void measured 37 cm (14.6") in height and 48 cm (18.9") in width. The curtain air bag was free of occupant contact points and damage.



Figure 15. Deployed right curtain air bag.



Figure 16. Right curtain air bag at the third row position.

Manual Safety Belt Systems – 2007 Subaru Legacy

The safety belt systems consisted of continuous loop webbing and sliding latch plates for all five positions. The front belts were equipped with adjustable D-rings and retractor mounted pretensioners. The D-ring's were adjusted to the full-up positions. The driver's retractor was equipped with an Emergency Locking Retractor (ELR).

The driver did not use the safety belt during the crash which was supported by the lack of loading evidence. Additional supporting evidence consisted of the actuated pretensioner which restricted the safety belt in the stowed position against the B-pillar.

The front right and rear seat retractors were switchable from the ELR to the Automatic Locking Retractor (ALR) mode. These seating positions were not occupied during the crash; however, the front right pretensioner actuated.

Manual Safety Belt Systems – 2006 Lexus GX 470

The safety belt systems in the Lexus consisted of continuous loop webbing and sliding latch plates for the first row, second row, and the outboard third row seats. The third row center seat consisted of a three point lap and shoulder belt with a detachable shoulder webbing. The front belts were equipped with adjustable D-rings. The driver's D-ring was adjusted to the full-down position. The driver's retractor was equipped with an Emergency Locking Retractor (ELR) and a pretensioner.

The driver utilized the safety belt during the crash which was supported by loading evidence on the lap and shoulder portions of the webbing and the latch plate. As a result

of the crash, the retractor pretensioner actuated. During this motion, the belt webbing was pulled through the D-ring and the latch plate resulting in frictional abrasions to the webbing and the latch plate. The driver loading resulted in a clothing transfer to the chest area of the belt webbing. The frictional abrasions from the latch plate were located from 85-89 cm (33.5-35”) above the floor anchor. The D-ring abrasions were located from 197-212 cm (77.6-83.4”) above the referenced point. The clothing transfer was located from 170-216 cm (67-85”) above the floor anchor.

The front right and rear seat retractors were switchable from the ELR to the Automatic Locking Retractor (ALR) mode. The front right safety belt was also equipped with a retractor pretensioner; however, it did not actuate during the crash.

The second row outboard seats were occupied by a 6-year-old male and a 9-year-old male. The 6-year-old male rear left passenger was positioned in a backless booster child seat and was restrained by the lap and shoulder belt. During the crash the rear left passenger loaded the safety belt which resulted in minor frictional abrasions to the latch and creasing of the webbing near the latch plate. The creasing of the webbing was located from 70-74 cm (27.6-29.1”) above the floor anchor. The right rear 9-year-old male passenger was restrained by the lap and shoulder belt at the time of the crash. This was supported by frictional abrasions that occurred to the latch plate from the passenger loading. A 3 cm (1.2”) crease was observed near the latch plate in the buckled position.

Child Safety Seat – 2006 Lexus GX 470

The SCI investigator conducted a partial interview with the spouse of the driver of the Lexus. It was determined during the interview, that the 6-year-old male rear left passenger was positioned in a backless booster seat. The interviewee stated that he would forward images of the safety seat via e-mail. These pictures were not received. The child’s exact positioning within the safety seat was not known and further information including make and model could not be determined.

Driver Demographics/Data – 2007 Subaru Legacy

Age/Sex:	55-year-old/Female
Height:	157 cm (62”)
Weight:	56 kg (123 lb)
Seat Track Position:	Mid-to-forward track position
Eyewear:	Unknown
Manual Safety Belt Use:	None used
Usage Source:	SCI vehicle inspection
Driver Egress from Vehicle:	Removed by rescue personnel
Mode of Transport	
From Scene:	Ground ambulance to a local hospital
Type of Medical Treatment:	Pronounced deceased 27 minutes post-crash

Driver Injuries – 2007 Subaru Legacy

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Transected aorta, 4.5cm from aortic root. Blood loss >20% by volume	Critical (420210.5,4)	Steering wheel
Avulsion of the superior and inferior vena cava	Severe (421806.4,4)	Steering wheel
Avulsed pulmonary arteries from left atrium	Severe (421008.4,4)	Steering wheel
Fracture of the 5 th cervical vertebra with subarachnoid hemorrhage of the spinal cord	Severe (640214.4,6)	Windshield/Indirect
Lung contusion	Serious (441402.3,9)	Steering wheel
Laceration of the esophagus	Serious (440804.3,4)	Steering wheel
Closed compound fracture of the right distal radius	Serious (752804.3,1)	Instrument panel
Closed compound fracture of the right distal ulna	Serious (753204.3,1)	Instrument panel
Compound femur fracture	Serious (851801.3,1)	Knee bolster/Indirect
Compound bimalleolar fracture with associated posteromedial 11 cm right ankle laceration	Serious (851614.3,1)	Foot controls
Multiple liver lacerations, with the largest being 9 cm	Moderate (541822.2,1)	Steering wheel
Pericardial sac lacerations	Moderate (441602.2,4)	Steering wheel
Sternum fracture (complete at level of 4 th rib)	Moderate (450804.2,4)	Steering column
Fracture of the right 5 th carpal	Moderate (752002.2,1)	Instrument panel
Comminuted fracture of the right talus	Moderate (853200.2,1)	Intruding toe pan
Comminuted fracture of the right calcaneus	Moderate (851400.2,1)	Intruding toe pan
Comminuted fracture of the right navicular bone	Moderate (852200.2,1)	Intruding toe pan
Multiple rib fractures	Moderate (450210.2,9)	Steering wheel
Multiple chest contusions	Minor (490402.1,0)	Steering wheel
Right forearm and hand 13x2 inch group of abraded lacerations	Minor (790602.1,1)	Instrument panel
Right lower extremity contusions around the knee	Minor (890402.1,1)	Knee bolster

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
3 cm (1”) laceration of the right distal leg	Minor (890602.1,1)	Foot controls

Source = Autopsy

Driver Kinematics – 2007 Subaru Legacy

The 55-year-old female driver of the Subaru was seated in a mid-to-forward track position and was unrestrained. Her posture was unknown. Her post-mortem Blood Alcohol Content (BAC) measured 0.39. The impaired driver allowed the vehicle to cross the center line of the road precipitating the crash. The force of the impact caused the retractor pretensioner to actuate and the driver’s frontal air bag to deploy.

The unrestrained driver responded to the frontal crash by initiating a forward trajectory. The driver contacted and began loading the deployed air bag with her chest. Her right hand/arm contacted the center instrument panel, center mirror, and windshield resulting in the identified injuries. Due to the severity of the crash, the driver loaded through the expanded air bag and fractured the steering wheel rim mounting flange. This loading resulted in the multiple rib fractures, the lung contusion, and the soft tissue chest injuries. The driver’s abdomen loaded and deformed the lower sector of the steering wheel rim resulting in the multiple liver lacerations. The chest loaded the steering wheel resulting in the sternum fracture, laceration of the pericardial sac, and the avulsions of the pulmonary artery, superior vena cava and inferior vena cava. The sudden deceleration of the chest from contacting the column caused the transection of the aorta. The driver’s head flexed over the top of the steering column and impacted the sun visor. This hyperflexion of the neck resulted in the fracture of the 5th cervical vertebra and the subarachnoid hemorrhage of the spinal cord at that level. The exposed anterior neck contacted the separated upper steering wheel rim resulting in the esophagus laceration. The driver’s lower extremities impacted the knee bolster resulting in the indirect right femur fracture and soft tissue injuries to the lower extremities. The driver sustained multiple right foot fractures from the intruding toe pan. The driver rebounded back into her seat where she came to rest.

Driver Demographics/Data – 2006 Lexus GX 470

Age/Sex: 39-year-old/Female
Height: 157 cm (62”)
Weight: 61 kg (134 lb)
Seat Track Position: Mid-track
Safety Belt Use: Three-point lap and shoulder safety belt
Usage Source: SCI inspection
Egress from Vehicle: Assisted by rescue personnel
Mode of Transport
From Scene: Ground ambulance
Type of Medical Treatment: Treated and released

Driver Injuries - 2006 Lexus GX 470

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Right knee sprain	Moderate (850826.2,1)	Knee bolster
Right knee abrasion (just above knee)	Minor (890202.1,1)	Knee bolster
Epistaxis	Minor (251090.1,4)	Driver air bag
Chest wall contusion 2-3 cm (0.8-1.2")	Minor (490402.1,1)	Shoulder belt
Right hand small laceration	Minor (790602.1,1)	Center mirror
Right hand abrasion	Minor (790202.1,1)	Center mirror
Right forearm contusion	Minor (790402.1,1)	Center mirror
Right lower abdominal abrasion	Minor (590202.1,1)	Safety belt
Left knee contusion	Minor (890402.1,2)	Knee bolster
Left shin contusion	Minor (890402.1,2)	Foot controls
Left hip contusion 2-3 cm (0.8-1.2")	Minor (890402.1,2)	Safety belt

Source = Hospital records

Driver Kinematics – 2006 Lexus GX 470

The 39-year-old female driver of the Lexus was seated in a mid-track position consistent with her stature. She had a reported height and weight of 157 cm (62 in) and 61 kg (134 lb). She was restrained at the time of the crash by the vehicle's three-point lap and shoulder belt system.

At impact, the safety belt retractor pretensioner actuated and the driver air bag deployed. The driver responded to the frontal impact by initiating a forward trajectory. The driver contacted and loaded the locked safety belt system with her torso and began to ride down the force of the crash. The loading of the safety belt resulted in the abdominal abrasions, chest wall contusion, and the left hip contusion. The driver's right hand contacted the center rear mirror resulting in the soft tissue injuries to the right hand and forearm. The driver's upper chest and face contacted the expanded air bag resulting in the epistaxis. The driver's lower extremities contacted the knee bolster. The driver sustained the right knee sprain, right knee abrasions, and left knee contusion as a result of this contact. The left lower leg contacted the foot controls resulting in the shin contusion. As the vehicle rotated to final rest, the driver rebounded back into the driver's seat and came to rest.

Rear Left Passenger Demographics/Data – 2006 Lexus GX470

Age/Sex: 6-year-old/Male
Height: 132 cm (52")
Weight: 24 kg (53 lb)
Seat Track Position: Not adjustable
Safety Belt Use: Three-point lap and shoulder safety belt with backless booster seat
Usage Source: SCI inspection
Egress from Vehicle: Assisted by rescue personnel
Mode of Transport
From Scene: Ground ambulance
Type of Medical Treatment: Treated and released

Rear Left Passenger Injuries – 2006 Lexus GX470

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Left clavicle fracture (Non-displaced, mid-shaft fracture)	Moderate (752200.2,2)	Safety belt
Left shoulder contusion	Minor (790402.1,2)	Safety belt
Left chest contusion	Minor (490402.1,2)	Safety belt
Right upper abdominal contusion	Minor (590402.1,1)	Safety belt

Source = Hospital records

Rear Left Passenger Kinematics – 2006 Lexus GX470

The 6-year-old male passenger was seated in the booster seat and was restrained by the vehicle's safety belt in the rear left position of the Lexus. At impact, the safety belt retractor locked. The child responded to the frontal impact by initiating a forward trajectory. The child loaded the locked safety belt with his torso and rode down the force of the impact. As a result of the safety belt loading, the child sustained a left clavicle fracture and soft tissue injuries to the shoulder chest and abdomen. The child rebounded back into his seat and came to rest. The use of the safety belt prevented the child from further contact with the interior components of the Lexus.

Rear Right Passenger Demographics/Data – 2006 Lexus GX470

Age/Sex: 9-year-old/Male
Height: 122 cm (48 in)
Weight: 31 kg (68 lb)
Seat Track Position: Not adjustable
Safety Belt Use: Three-point lap and shoulder safety belt
Usage Source: SCI inspection
Egress from Vehicle: Assisted by rescue personnel
Mode of Transport
From Scene: Ground ambulance
Type of Medical Treatment: Treated and released

Rear Right Passenger Injuries – 2006 Lexus GX470

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Superficial tongue laceration, (approx. 0.5cm to the top of tongue)	Minor (243402.1,8)	Self inflicted
Right upper chest contusion	Minor (490402.1,1)	Safety belt

Source = Hospital records

Rear Right Passenger Kinematics – 2006 Lexus GX470

The 9-year-old male was seated in the rear right of the Lexus and was restrained by the vehicle's safety belt. At impact, the safety belt retractor locked. The child responded to the frontal impact by initiating a forward trajectory. The child loaded the locked safety belt with his torso and rode down the force of the impact. The safety belt loading was evidenced by the contusion of the upper right chest. During the ride down of the impact, the child bit his tongue resulting in the tongue laceration. The use of the safety belt minimized the child's contact with the interior components of the Lexus, thereby minimizing his injuries. There was no contact evidence to support this child passenger's involvement with the deployed curtain air bag.

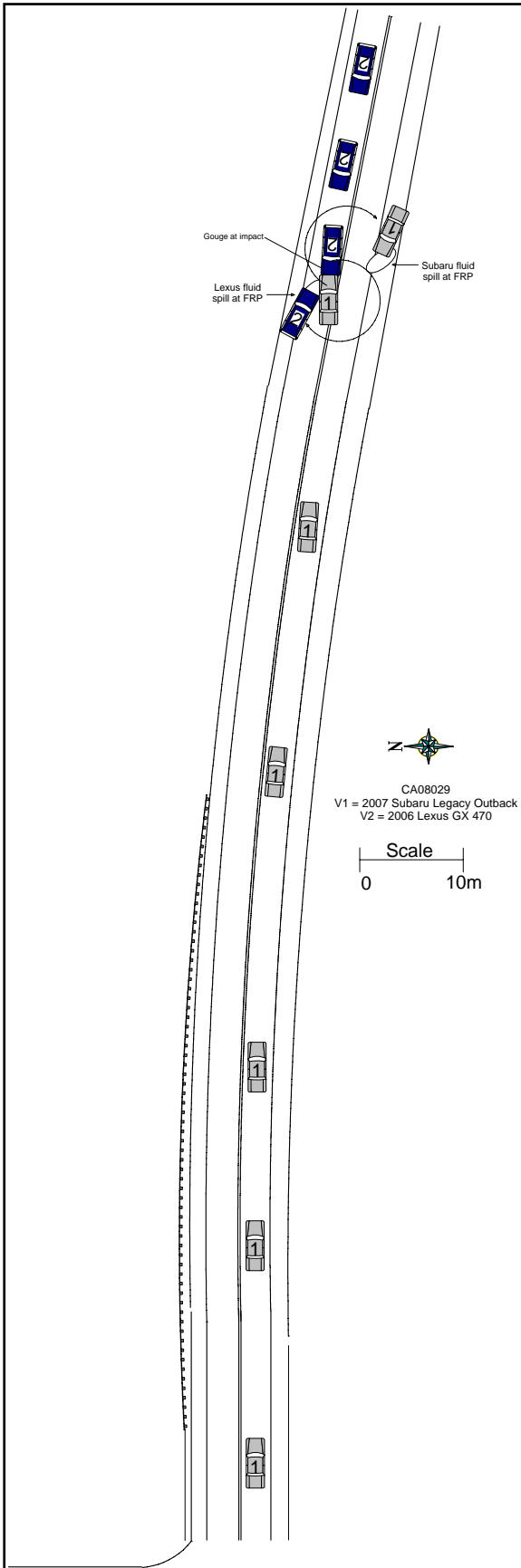


Figure 17: Scene Schematic