TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

Veridian
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VERIDIAN ON-SITE REDESIGNED AIR BAG DEPLOYMENT INVESTIGATION
VERIDIAN CASE NO. CA99-003
VEHICLE: 1999 LEXUS LX470 SPORT UTILITY
LOCATION: TENNESSEE
CRASH DATE: MARCH 1999

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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 a single vehicle run-off-road crash that involved a 1999 Lexus LX470 sport utility vehicle. The Lexus was equipped with redesigned frontal air bags for the driver and right passenger positions. The driver of the vehicle was distracted from his driving task by the use of a cellular telephone and an instrument panel mounted cassette tape player. As he entered a left curve in an 89 km/h (55 mph) speed zone, the driver allowed the vehicle to drift onto the right shoulder. He applied a counterclockwise steering input to redirect the vehicle onto the eastbound travel lane. Due to the excessive steering input, the driver applied a rapid countersteer maneuver in a clockwise direction. This subsequent steering input induced a clockwise yaw as the Lexus broke traction on the dry asphalt road surface and rotated in a clockwise direction. The vehicle subsequently departed the right edge of the roadway and impacted a concrete bridge abutment with the front right area of the vehicle. The 11 o'clock impact force resulted in a velocity change of 48 km/h (30 mph) which deployed the redesigned air bag system. The unbelted 67 year old male driver loaded the deployed air bag and the steering wheel rim which resulted in a ruptured liver and a collapsed lung. He was transported by helicopter to a major medical/trauma center where he was admitted in critical, but stable condition. He was subsequently released from the hospital 13 days following the crash.			
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BACKGROUND

This on-site investigation focused on a single vehicle run-off-road crash that involved a 1999 Lexus LX470 sport utility vehicle **(Figure 1)**. The Lexus was equipped with redesigned frontal air bags for the driver and right passenger positions. The driver of the vehicle was distracted from his driving task by the use of a cellular telephone and an instrument panel mounted cassette tape player. As he entered a left curve in an 89 km/h (55 mph) speed zone, the driver allowed the vehicle to drift onto the right shoulder. He applied a counterclockwise steering input to redirect the vehicle onto the eastbound travel lane. Due to the excessive steering input, the driver applied a rapid countersteer maneuver in a clockwise direction. This subsequent steering input induced a clockwise yaw as the Lexus broke traction on the dry asphalt road surface and yawed in a clockwise direction. The vehicle subsequently departed the right edge of the roadway and impacted a concrete bridge abutment with the front right area of the vehicle. The 11 o'clock impact force resulted in a velocity change of 48 km/h (30 mph) which deployed the redesigned air bag system. The unbelted 67 year old male driver loaded the deployed air bag and the steering wheel rim which resulted in a ruptured liver and a collapsed lung. He was transported by helicopter to a major medical/trauma center where he was admitted in critical, but stable condition. He was subsequently released from the hospital 13 days following the crash.

Figure 1. On-scene view of the Lexus at final rest.

The crash occurred in March 1999, during daylight hours. This case was initially identified through the media which covered the crash in newspapers, television and radio broadcasts. The Veridian SCI team contacted NHTSA on Monday, March 8, regarding the crash and an on-site investigation effort was assigned on Tuesday, March 9th. The on-site investigation was initiated on Wednesday, March 10, for the inspection and documentation of the vehicle and crash scene.

SUMMARY

Crash Site

The crash occurred on a two lane state route in a posted 89 km/h (55 mph) speed zone. In the vicinity of the crash site, the asphalt road surface curved to the left with respect to the eastbound vehicle's direction of travel. The radius of curvature was 521 m (1,710'). The grade was measured at 1 percent, positive to the east with a super-elevation of 2 percent. Both travel lanes were bordered by narrow asphalt shoulders with drop-offs adjacent to both shoulders. Several creeks ran under the roadway with concrete bridge structures spanning the waterways. The concrete bridge railings were 82.6 cm (32.5") in height and 25.4 cm (10.0") in width. The railings were comprised of a poured footer with 10 x15 cm (4x6") pre-cast concrete pillars and a 12.7 x 25.4 cm (5.0 x 10.0") wide continuous pour concrete top railing.

Vehicle Data

The involved vehicle was a 1999 Lexus LX470, full time four-wheel drive sport utility vehicle. The Lexus was a 4-door body configuration with a rear liftgate and a tempered glass sunroof. The Lexus was equipped with redesigned frontal air bags for the driver and passenger seated positions which deployed as a result of the crash. The Lexus was also equipped with pyrotechnic pretensioners in the front outboard seat belt systems. Although the driver was not restrained and there was no front right passenger in the vehicle, both pretensioners fired which locked the 3-point continuous loop belt webbings taut against the respective B-pillars.

In addition to the safety systems, the Lexus was equipped with a conventionally mounted V-8 engine, four-wheel power-assisted disc brakes with anti-lock (ABS), and P275/70R16 mud and snow rated tires mounted on chromed steel wheel rims. The vehicle was manufactured on 9/98 and was identified by vehicle identification number JT6HT00W3X0 (production number deleted). The electronic odometer could not be read, therefore the recorded mileage at the time of the crash was unknown.

The interior of the Lexus was configured with front bucket seats, a split bench with folding backs in the second row, and a split folding bench (forward facing) in the rear area which provided the vehicle with seven seated positions. All seats were covered with leather. The Lexus was equipped with 3-point lap and shoulder belts for the six outboard positions and the second seat, center position. The Lexus was equipped with a center instrumented panel mounted cassette player with an internal compact disc (CD) player. A cassette was in the play mode of the audio system. In addition, the Lexus was equipped with an optional OEM Lexus cellular phone handset that was hardwired into the center console of the vehicle **(Figure 2)**. A remote cellular phone control module was mounted between the left spokes of the steering wheel rim **(Figures 3 and 4)**. This control module contained a remote microphone/speaker, volume controls, and a dial and scroll buttons for remote calling. The system also featured a voice activated dialing menu system. The antenna for this cellular telephone system was fused to the lower aspect of the right rear quarter window between the C- and D-pillars.

Figure 2. Hard wired cellular phone in the center console.

Figure 3. Steering wheel control module for the cellular phone.

Figure 4. Side view of the remote control module.

Pre-Crash

The driver of the Lexus sport utility vehicle was a 67 year old male with an estimated height of 175 cm (69") and weight of 81 kg (180 lb). He was not wearing the manual 3-point lap and shoulder belt system. The driver was en route to his residence and was traveling in an easterly direction on the state route at an estimated speed of 89 km/h (55 mph). It was initially reported through the media that he was listening to the cassette in the instrument panel mounted player and talking to a family member on the cellular telephone. His residence was located approximately 1.6 km (1.0 mile) east of the impending crash site.

On his approach to the crash site, the driver successfully negotiated a right curve that terminated into a left curve which formed a long S-curve configuration. As he entered the left curve, the driver was probably distracted from his driving task by the cassette player and the cellular phone conversation. He allowed the vehicle to drift onto the right shoulder **(Figure 5)**. The right side tires marked on the asphalt shoulder for a distance of 30 m (98'). The driver applied a counterclockwise (CCW) steering input to redirect the Lexus onto the eastbound travel lane. As the vehicle traversed the travel lane, he subsequently applied a rapid countersteer maneuver in a clockwise (CW) direction. The rapid CW steering input induced a CW yaw in the eastbound travel lane. The left side tire marks began 27.4 m (89.9') east of the re-entry from the outboard shoulder and continued for a distance of 31.4 m (103.3') in the eastbound travel lane **(Figure 6)**. The tire marks identified approximately 23 degrees of CW yaw. The Lexus departed the right edgeline of the roadway, traversed a 1.2 m (4.0') asphalt shoulder, and impacted the blunt end of a concrete bridge railing.

Figure 5. Area of initial departure from the eastbound travel lane.

Figure 6. Left side yaw marks and rotational trajectory of the Lexus.

Crash

The front center and right area of the Lexus impacted the 25 cm (10") wide concrete bridge rail **(Figure 7)** resulting in an 11 o'clock impact force. The damage and trajectory algorithm of the WinSMASH program computed an impact speed of 59.3 km/h (36.8 mph). The impact crushed the bumper reinforcement bar to a maximum depth of 82.8 cm (32.6"), located inboard of the right frame rail **(Figure 8)**. The velocity change was computed by the damage algorithm of the WinSMASH program at 48 km/h (30 mph) with a longitudinal component of -41.5 km/h (-25.8 mph) which deployed the vehicle's redesigned air bag system. The impact fractured approximately 3 m (10') of the concrete

Figure 7. Struck bridge railing and final rest area of the Lexus.

bridge railing which redirected the Lexus back onto the travel lanes. It should be noted that an estimated 70 kg (150 lb) segment of the bridge railing was displaced 22 m (72') to the far side of the creek, located 4 m (13') below the bridge.

Figure 8. Frontal damage to the Lexus LX470.

The Lexus rotated approximately 175 degrees CW as its center of gravity continued in an easterly direction. The left rear quarter panel area of the vehicle sideslaped the remaining concrete bridge railing which resulted in minor damage to the sheet metal, rear bumper fascia, and the left tail lamp lens. The maximum crush associated with this impact was 0.9 cm (0.375") with a direction of force of 9 o'clock.

The Lexus continued to rotate CW and traveled a longitudinal distance of 6.4 m (21.0') from its initial point of impact (POI) to final rest. At rest, The Lexus had rotated approximately 216 degrees CW from the initial POI, coming to rest facing in a northerly direction, diagonal to the eastbound travel lane. The crash schematic is attached as **Figure 17** (Page 13).

Post-Crash

The driver came to rest slumped forward in the left front position of the vehicle. Although not physically entrapped, rescue personnel used hydraulic equipment to cut structural components from the Lexus to aid in the removal of the driver from the vehicle. The left front door was jammed closed due to rearward displacement of the frontal structure. Firefighters removed the left front door from the vehicle and cut the left upper A-pillar between the beltline and header locations. In addition, the sill of the vehicle was cut aft of the A-pillar and the frontal structure was pulled forward to provide sufficient room to remove the incapacitated (due to injury) driver.

The driver was subsequently placed on a backboard and a gurney prior to helicopter transport to a major medical/trauma center. The hospital was located approximately 32 km (20 miles) air miles from the crash site. The driver was admitted in critical condition where he was hospitalized for 13 days for treatment of his injuries.

VEHICLE DAMAGE

Exterior:

The Lexus LX470 sport utility vehicle sustained severe frontal damage from the initial impact sequence with the concrete bridge railing **(Figure 9)**. Maximum crush was 82.8 cm (32.6") located on the bumper reinforcement bar, inboard of the right frame rail. The direct contact damage on the bumper fascia began 19.7 cm (7.75") right of center and extended 99.1 cm (39.0") to the left corner. The fascia separated from the vehicle during the engagement, therefore the damage pattern on the fascia did not represent the residual crush profile at the reinforcement bar. The damage profile was

Figure 9. Frontal damage to the Lexus LX470.

located right of center, inboard of the frame rails. The impact deformed the full frontal width of the Lexus resulting in a direct and induced damage length (Field L) of 55.9 cm (22.0") which extended from corner-to-corner of the reinforcement bar. Six equidistant crush measurements were documented at the level of the bumper reinforcement bar. This resultant damage profile was as follows: C1 = 30.7 cm (12.1"), C2 = 32.8 cm (12.9"), C3 = 46.7 cm (18.4"), C4 = 57.4 cm (22.6"), C5 = 61.2 cm (24.1"), C6 = 44.7 cm (17.6"). The maximum crush value of 82.8 cm (32.6") was located 41.9 cm (16.5") inboard of the left frame rail. The Collision Deformation Classification (CDC) for this impact event was 11-FZEW-3.

The impact damaged and deformed the entire frontal structure of the vehicle, displacing the conventionally mounted V-8 engine into the cowl of the front passenger compartment. The engine block and the transmission and transfer case housings were cracked due to the displacement.

As previously noted, rescue personnel cut the left front door, left upper A-pillar, and the left sill of the Lexus and pulled the frontal structure forward to aid in the removal of the driver. The left wheelbase, although altered post-crash, was reduced in length by 8.4 cm (3.3") while the right wheel base was reduced by 13.2 cm (5.2").

The rearward displacement of the frontal structure resulted in buckling of the left front door. The latch remained closed as the door was jammed in the fully closed position by the damage. The side glazing of the door shattered during the crash. All remaining doors, inclusive of the liftgate, remained closed during the crash and were fully operational post-crash. The tempered side glazing of the left rear door, quarter window, and entire right side remained intact. The sunroof was closed at the time of the crash and was not damaged. Rescue personnel cut the windshield from the vehicle which was cracked by the frontal deformation. It was unknown if the glazing was penetrated by displacement of the hood.

The secondary damage to the left rear quarter panel area was minor in severity **(Figure 10)**. The direct contact damage began 63.5 cm (25.0") rearward of the left rear axle and extended 43.2 cm (17.0") to the rear corner of the bumper fascia. The damage consisted of vertically oriented abrasions with a maximum crush depth of 0.9 cm (0.375"). The assigned CDC for this damage pattern was 09-LBEW-1. The Lexus was considered a total loss with a replacement value of approximately $60K.

Figure 10. Secondary sideslap damage to the left rear quarter panel.

Interior:

The interior of the Lexus sport utility vehicle sustained moderately severe damage that was associated with air bag deployment, driver contact, and exterior deformation that resulted in intrusion of numerous frontal components **(Figure 11)**. The supplemental redesigned frontal air bag system deployed as designed. The driver air bag deployed from the steering wheel mounted module assembly while the passenger air bag deployed from the top right instrument panel. Damage was limited to the tearing of the cover flaps at the designated tear points.

Figure 11. Overall view of the driver compartment.

The unrestrained driver initiated a forward trajectory in response to the frontal impact force and contacted the knee bolster, deployed air bag, the steering wheel rim, left door panel, and possibly the left upper A-pillar. The driver's left knee impacted the bolster cover 66-76 cm (26-30") left of the vehicle's centerline and 25-41 cm (10-16") below the top "brow" surface of the instrument panel. The contact deformed the plastic trim panel inward to an approximate depth of 3.2 cm (1.25") at the outboard edge of the bolster. His right knee contacted the bolster 30-38 cm (12-15") left of center and 33-47.0 cm (13-18.5") below the top surface of the mid instrument panel. The contact deformed the plastic bolster cover and dented the subpanel to a depth of 3.8 cm (1.5").

The driver's chest and abdominal regions loaded the deployed air bag, however, due to the high severity of the crash, and the vertical displacement of the steering column, he loaded through the bag and engaged the steering wheel rim. The upper aspect of the rim was displaced 1.9 cm (0.75") forward **(Figure 12)** which resulted from his thoracic loading against the bag and subsequent compression of the bag against the wheel assembly. As the column rotated upward due to rearward displacement of the engine in to the cowl, The driver's right upper abdomen loaded the edge of the steering wheel rim at the 5 o'clock sector. This was within the area of the spokes where the wheel rim was the most rigid. The right spokes were deflected forward minimally, evidenced by expansion of the gap between the air bag module cover and the covered spokes of the wheel **(Figure 13)**. In addition to wheel deformation, the driver minimally compressed the energy absorbing column. The left shear capsule was displaced 0.6 cm.25") while the right shear was **(Figure 14)** separated 1.2 cm (0.5").

Figure 12. Deflection of the upper steering wheel rim.

Figure 13. Right steering wheel spoke deflection.

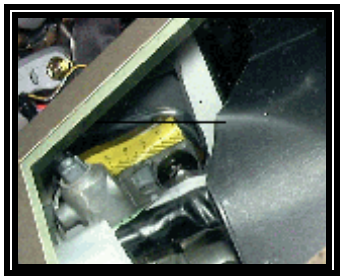

Figure 14. Right shear capsule separation.

As the Lexus rotated in a clockwise direction and sideslaped the bridge rail, the driver moved to the left with respect to the vehicle. His left hip area contacted the padded integral armrest of the left front door panel. The contact was evidenced by a blue fabric scuff with minimal compression of the panel. The contact was located 39.3-48.3 cm (15.5-19.0") rearward of the leading edge of the door and 21.6-25.4 cm (8.5-10.0") below the beltline.

The left front door and left upper A-pillar were cut from the vehicle during the extrication procedures for the driver. The left upper A-pillar was found on the floor of the vehicle during the inspection process. A possible scuff mark was noted to the trim panel of the pillar with a single strand of hair adhered to the pillar surface. Although is was reported that the driver did not sustain head injuries, he possibly contacted the pillar as he responded to the 11 o'clock impact force.

The intrusion of frontal components into the passenger compartment was distributed across the full width of the vehicle. Maximum intrusion involved 38.7 cm (15.25") of rearward displacement of the front right toe pan. Rescue personnel used hydraulic equipment to remove the left front door and the left upper A-pillar from the vehicle. In addition, they cut the sill of the Lexus, aft of the A-pillar and pulled the front left structure forward to provide more space to treat and remove the injured driver from the vehicle. This rescue action altered the magnitude of the intrusion into the driver compartment. The following table identifies the intruding component, occupant position, magnitude, and the direction of each intrusion.

Table 1. Intrusion Values

Intruding Component	Occupant Position	Magnitude	Direction
Left mid instrument panel	Front left (driver)	Unknown, pulled 13 cm forward of original position	Longitudinal
Mid point of steering assembly	Front left (driver)	Unknown, pulled 13 cm forward of original position	Longitudinal
Left toe pan	Front left (driver)	10.2 cm (4.0")	Longitudinal
Center mid instrument panel	N/A	6.4 cm (2.5")	Longitudinal
Glove box door	Front right	20.3 cm (8.0")	Longitudinal
Right mid instrument panel	Front right	3.8 cm (1.5")	Longitudinal
Right toe pan	Front right	38.7 cm (15.2")	Longitudinal

REDESIGNED AIR BAG SYSTEM

The 1999 Lexus LX470 luxury sport utility vehicle was equipped with frontal air bags for the driver and front right passenger positions. The air bag system deployed as a result of the severe frontal impact

sequence with the concrete bridge railing. The air bag system was identified by Toyota as a redesigned system although no labeling distinguished the air bag system as redesigned.

The system consisted of a single point control module, the steering wheel mounted driver air bag module, the passenger air bag module that was top mounted in the right instrument panel, the steering wheel clockspring assembly, and the instrument panel mounted air bag indicator lamp. At the time of vehicle inspection, the damaged battery was removed from the vehicle and no alternate power was available to test the status of the indicator lamp. The Lexus was not equipped with an on-board electronic data recorder.

The front driver air bag deployed from a module assembly that was contained within the four spoke steering wheel assembly. The spokes were located at the 3/9 and 5/7 o'clock positions. The Lexus was equipped with an electronically controlled tilt and telescoping steering assembly. The specific adjustment positions of these features could not be determined from the involved Lexus due to vehicle damage from the crash and extrication efforts. An exemplar vehicle was inspected which yielded approximately 10 degrees of tilt column adjustment with a mid point column angle of 28 degrees. The telescopic feature provided 3.2 cm (1.25") of fore and aft movement to the column. The crash involved Lexus had a measured steering column angle of 42 degrees which was altered by the efforts of the rescue personnel.

The driver air bag deployed from a typical module assembly with H-configuration cover flaps. The horizontal team seam was 15.2 cm (6.0") in length with an upper flap height of 8.9 cm (3.5") and a lower flap height of 5.7 cm (2.25"). Both flaps tapered to the horizontal hinge points. There no damage or contact evidence to the cover flaps.

The driver air bag was constructed of two panels that were sewn together with an internal peripheral seam. The fabrics were light blue in color and were covered with a sealant on the inside surface. The bag was vented by two 2.2 cm (0.9") diameter ports that were located on the forward panel at the 11 and 1 o'clock sectors. The vent ports were centered 7.6 cm (3.0") below the peripheral seam. The diameter of the bag in its deflated state was 67.3 cm (26.5"). The driver bag was tethered by 2 internal tethers located at the 3 and 9 o'clock positions. The center tether reinforcement was 16.5 cm (6.5") in diameter. Maximum excursion of the bag was 15.2 cm (6.0") at the tether locations and 22.9 cm (9.0") at the center of the tether reinforcement. The driver air bag was identified by the following alpha-numeric sequences:

68070554
S
45165-60030-A
BBN2163
4ES987302
200898

There was no damage or contact evidence to the front driver air bag. Several blood spatters were noted to the bag, however, these appeared to have resulted post-crash.

The front right passenger air bag deployed from a top mount module in the right instrument panel. The single cover flap design was hinged at the forward aspect and opened in an upward direction toward the windshield. The cover flap was trapezoidal in shape with a lateral length of 26.7 cm (10.5") at the tear seam and 27.3 cm (10.75") at the hinge point. The depth of the flap at the left (inboard) side was 16.5 cm (6.5") while the right side depth was 14.6 cm (5.75"). The multilayered cover flap was constructed of a rigid plastic bottom layer with a foam mid layer that was covered with the vinyl outer flap material. The overall thickness of the flap was 2.2 cm (0.875"). The flap was tethered by two braided rope-type tethers that were affixed to the sides of the flap, 3.8 cm (1.5") inboard of the leading edge. The flap tethers restricted the vertical travel of the cover flap to 11.4 cm (4.5") which probably dictated the deployment path of the passenger bag.

The front passenger air bag was constructed of a typical woven-type nylon fabric, however, the fabric was extremely rigid in its deflated state. The throat of the bag extended 16.5 cm (6.5") out from the inflator/manifold. The overall bag dimensions in its deflated state were 59.7 cm (23.5") in depth, 67.3 cm (26.5") in height, and approximately 73.7 cm (29.0") in width. The passenger air bag was vented by two 5.1 cm (2.0") diameter ports located on the side panels of the bag, centered approximately 31.8 cm (12.5") outboard of the inflator. There was no driver contact evidence or damage to the passenger air bag.

In addition to the supplemental redesigned frontal air bag system, the Lexus LX470 was equipped with pyrotechnic pretensioners in the front outboard 3-point lap and shoulder belt systems. The pretensioners were located in the lower aspect of the B-pillars and spooled-up the belt webbings at the retractor. Both front belt systems were stowed against the respective B-pillars at the time of the crash, therefore as the pretensioners fired, the webbings were spooled taut against the pillars. At the time of vehicle inspection, which occurred 4 days following the crash, the belt webbings remained taut in the stowed positions with the retractors locked. This system did not require buckling of the front belt systems to fire the pretensioners.

MANUAL RESTRAINT SYSTEMS

The Lexus was equipped with 3-point, continuous loop lap and shoulder belt systems at all seven seated positions within the vehicle. The front outboard belt systems consisted of dual mode webbing sensitive and inertia activated locking retractors located in the base of the B-pillars. The pretensioners were cabled to the retractors which fired at the deployment of the frontal air bag system. A sliding latchplate was incorporated into the front belt systems with a positioning stop button affixed to the mid point aspect of the webbing when the belt is stowed against the B-pillar. In addition to the dual mode retractor, the front right belt retractor was switchable (locking mode) for use with a forward facing child safety seat. The front seat belt systems were also equipped with adjustable upper anchorages (D-rings). Both D-rings were adjusted to the full-up positions. The manually operated D-rings provided 12.1 cm (4.75") of vertical adjustment. The driver was not restrained by the manual belt system. The belt hardware (latchplate) and webbing did not yield evidence of routine usage prior to this crash.

The 60/40 split bench second seat was equipped with 3-point lap and shoulder belt systems for the three designated positions. The continuous loop belt webbings were fitted with sliding latchplates and dual mode locking retractors with switchable modes for child safety seats. The outboard positions were equipped with adjustable upper anchorages. All three belt systems were found neatly stowed in their respective positions.

The third row of seats consisted of folding, forward facing seats positioned at the outboard aspects of the cargo area. These seat backs folded forward onto the seat cushions and the units then folded against the side walls of the vehicle. At the time of the vehicle inspection, the folding seats were in the stowed position. The 3-point lap and shoulder belt systems for the outboard seat positions were affixed to the D-pillars. These belts were configured the same as the other systems within the vehicle, however, the upper anchorages were fixed.

DRIVER DEMOGRAPHICS

Age/Sex:	67 year old male
Race/Ethnic Origin:	White (non-hispanic)
Height:	175.3 cm (69.0")
Weight:	81.6 kg (180.0 lb)
Manual Restraint Usage:	None
Usage Source:	Vehicle inspection, first responders to the crash scene
Vehicle Familiarity:	Several months
Route Familiarity:	Daily, resides approximately 1.6 km (1.0 mile) from crash site
Trip Plan:	Returning to residence
Mode of Transport From Scene:	Helicopter to a major medical/trauma center
Type of Medical Treatment:	Admitted in critical condition for treatment of his internal injuries.
Length of Hospitalization:	13 days

DRIVER INJURIES

Injury	***Injury Severity (AIS 90)***	***Injury Mechanism***
Ruptured liver, not further specified	Severe (541840.4,1)	Edge loading of the steering wheel rim
Collapsed lung	N/A, not coded under AIS 90	Compression of the air bag against the steering wheel assembly

** The above injuries were identified by hospital personnel who released statements to the media regarding the status of the driver.*

DRIVER INJURIES/KINEMATICS

The driver of the Lexus sport utility vehicle was seated in a presumed upright driving posture with the power-seat adjusted 3.2 cm (1.25") forward of the full rear position.. The leather seat cushion was adjusted to a near horizontal attitude with the seat back reclined 20 degrees. The driver was not restrained by the manual 3-point lap and shoulder belt system. Belt usage was determined from two sources. The first was the observations of the police and rescue personnel who arrived on-scene and found the driver unrestrained. Secondly, the front belt systems were equipped with pyrotechnic pretensioners which fired with the supplemental frontal air bag system. The pretensioners spooled-up the belt slack and retracted the belts in the stowed positions taut against the B-pillars. Furthermore, the belt webbing and hardware did not yield evidence of routine usage.

At impact, the redesigned frontal air bag system deployed. The severe exterior damage resulted in intrusion of multiple interior components. Rearward displacement of the engine against the cowl resulted in vertical displacement of the tilt steering column. Although altered by post-crash extrication activities, the post-crash column angle was measured at 46 degrees.

The driver responded to the 11 o'clock impact force by moving forward and to his left **(Figure 15)**. His buttocks slid on the relatively flat profile of the leather front bucket seat as he moved into the deployed redesigned air bag. His upper thoracic area loaded the deployed air bag, however, due to the high severity of the crash, he compressed the air bag against the wheel rim which deformed the upper steering wheel rim 1.9 cm (0.75") forward. Air bag and the subsequent wheel loading resulted in an apparent collapse of one of the driver's lungs. The right upper quadrant of his abdominal region loaded the edge of the steering wheel rim at the right spoke location resulting in a ruptured liver. The edge loading of the right steering wheel spokes resulted in minimal forward displacement of the right spokes. The combination of thoracic and abdominal loading compressed the energy absorbing steering column 1.2 cm (0.5"). Column displacement was documented by forward movement of the shear capsules.

Figure 15. Trajectory of the driver into the deployed redesigned front left air bag.

The driver's knees contacted the knee bolster on each side of the steering assembly **(Figure 16)**. The left knee deformed the bolster trim panel to a depth of 3.2 cm (1.25") located at the left edge of the panel. The right knee contact was located adjacent to the column, 30-38 cm (12-15") right of center. This contact was evidenced by 3.8 cm (1.5") of panel compression which involved the subpanel assembly. There was no reported injury to the driver's lower extremities.

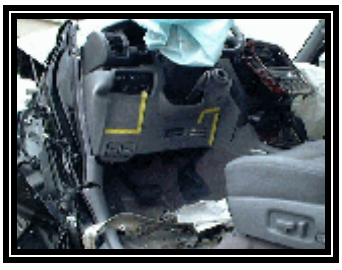

Figure 16. Driver knee loading to the bolster.

During the CW rotation of the vehicle, the driver's left hip contacted the protruding integral armrest on the left door panel. A blue fabric transfer was noted to the panel 39.4-48.3 cm (15.5-19.0") rearward of the leading edge of the door. The area surrounding the transfers was slightly bowed in the outward direction. There was no reported injury to the hip/pelvic area of the driver. He came to rest in the front left seat position of the vehicle. There were several spatters of blood on the deployed front left air bag which probably occurred post-crash.

MEDICAL TREATMENT

The driver was removed from the vehicle and transported by helicopter to a major medical/trauma center where he was admitted in critical condition. He was discharged from the medical facility 13 days following the crash which a prognosis of a full recovery from his injuries.

CAUSAL FACTORS

It should be noted that although the cellular telephone was attributed as a possible causal factor for this crash, the hardwired handset was not damaged in the crash. The unit was found by the SCI investigators in the console caddy. Due to the severity of the crash, it would be likely that the unit would have been damage if it was in use at the time of the crash. The SCI investigators believe that the driver was using the remote module feature of the cellular telephone mounted to the left side of the steering wheel spokes and was distracted by both the phone conversation and the cassette tape player that was mounted in the upper mid instrument panel.

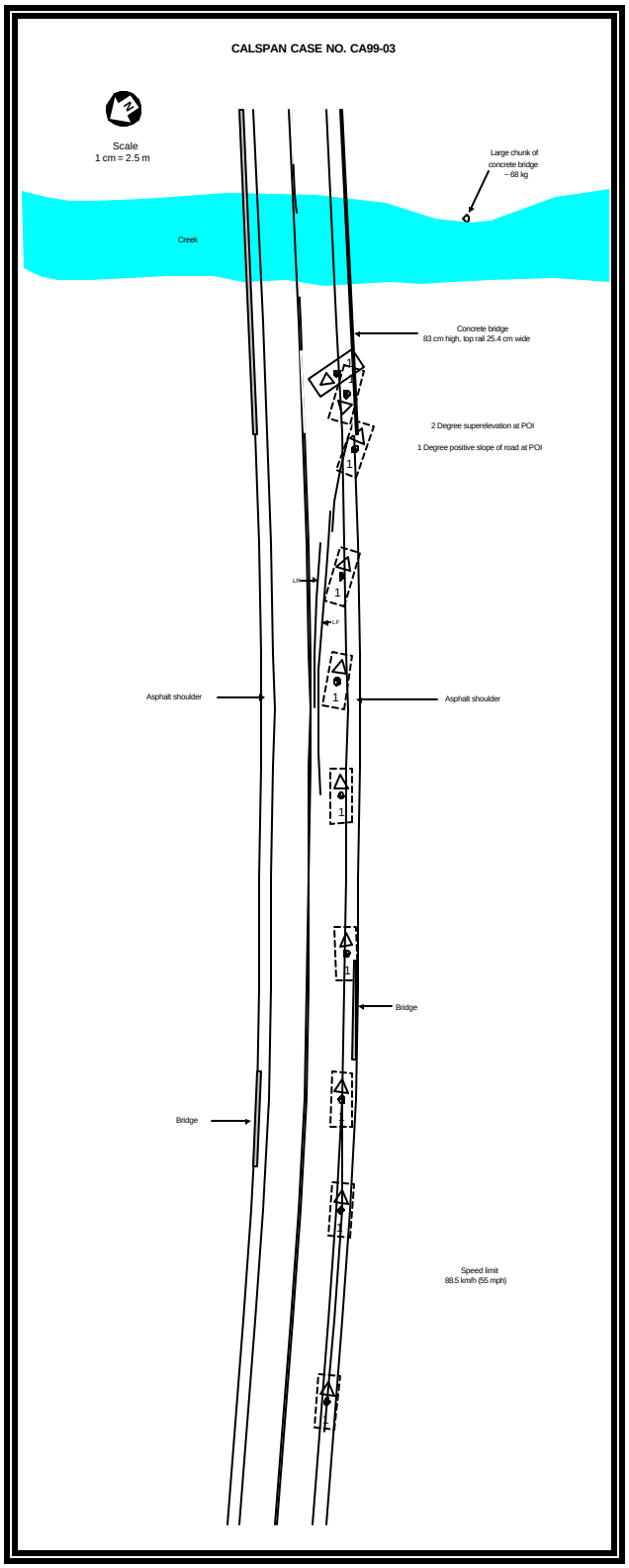

Figure 17. Crash Schematic