

**TRANSPORTATION SCIENCES
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**GENERAL DYNAMICS ON-SITE ADVANCED OCCUPANT PROTECTION SYSTEM
INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

CASE NO. CA03-044

VEHICLE – 2003 LEXUS SC 430

LOCATION - STATE OF FLORIDA

CRASH DATE – JULY 2003

Contract No. DTNH22-01-C-17002

Prepared for:

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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.

TECHNICAL REPORT STANDARD TITLE PAGE

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<i>16. Abstract</i> This on-site investigative effort focused on the crash severity, the performance of the Advanced Occupant Protection System (AOPS), and the resulting injury mechanisms for the driver of a 2003 Lexus SC430. The AOPS consisted of dual-stage frontal air bags, safety belt pretensioners, an occupant sensing system for the front right seating position, and an Event Data Recorder (EDR). The SC430 was involved in a run-off-road crash with a tree that resulted in severe damage to the vehicle. The police report stated that the driver exhibited signs of alcohol intoxication. He relinquished control of the vehicle and the Lexus departed the left road edge and impacted a tree on the curbed median of a divided highway. The impact was sufficient to deploy the dual-stage driver's air bag. Since the front right seat was not occupied, the front right passenger's air bag did not deploy. The driver was restrained by the manual 3-point lap and shoulder belt. The driver sustained police-reported C-level injuries and was transported by ambulance to a local hospital. His admission status was not reported.			
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LOCATION - STATE OF FLORIDA
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BACKGROUND

This on-site investigative effort focused on the crash severity, the performance of the Advanced Occupant Protection System (AOPS), and the resulting injury mechanisms for the driver of a 2003 Lexus SC430. The AOPS consisted of dual-stage frontal air bags, safety belt pretensioners, an occupant sensing system for the front right seating position, and an Event Data Recorder (EDR). The SC430 (**Figure 1**) was involved in a run-off-road crash with a tree that resulted in severe damage to the vehicle. The police report stated that the driver exhibited signs of alcohol intoxication. He relinquished control of the vehicle and the Lexus departed the left road edge and impacted a tree on the curbed median of a divided highway. The impact was sufficient to deploy the dual-stage driver's air bag. Since the front right seat was not occupied, the front right passenger's air bag did not deploy. The driver was restrained by the manual 3-point lap and shoulder belt. The driver sustained police-reported C-level injuries and was transported by ambulance to a local hospital. His admission status was not reported.



Figure 1. Damaged 2003 Lexus SC430

The Police Accident Report (PAR) for this crash was forwarded to the NASS Zone Center following routine sampling activities by NASS PSU 41 in August, 2003. The PAR was forwarded to the General Dynamics SCI team for review and the data was e-mailed to NHTSA as a potential AOPS/EDR download investigation. The SCI team secured cooperation from the insurance company and gained access to the vehicle and approval to retrieve the EDR for download. NHTSA approved the case for on-site investigation on August 6, 2003. The EDR was forwarded by NHTSA to Toyota for analysis, and the EDR summary was subsequently forwarded to the SCI team by NHTSA. Multiple attempts to locate the driver were unsuccessful.

VEHICLE DATA – 2003 LEXUS SC430

The 2003 Lexus SC430 was identified by the Vehicle Identification Number (VIN): JTHFN48Y130 (production sequence omitted). The Lexus was a two-door coupe configured with a power retractable hard-top roof. The Lexus was equipped with a 4.3 liter, V-8 engine, a five-speed automatic transmission, power front and rear disc brakes with ABS, emergency braking assist, stability control, traction control, an engine immobilizer, a remote anti-theft alarm system, dusk-sensing headlamps, speed-proportional power steering, and a tilt/telescoping steering column. The memory settings for the steering wheel, steering column, and driver's seat

were activated through an entry/exit system when the key was placed in or removed from the ignition switch. The Lexus was also equipped with exterior automatic dimming electrochromatic mirrors, and reverse tilt dual mirrors, which provided a curb view when vehicle operated in reverse.

The Lexus was equipped with an indirect Tire Pressure Monitoring System (TPMS), which monitored tire pressure conditions. The Lexus had a tire pressure sensor built in each wheel. The Lexus was configured with aluminum/alloy wheels and Dunlop SP Sport 5000 DSST Crr 245/40ZR18 Run Flat tires. The manufacturer’s recommended tire pressure for the Run Flat tires was 230 kPa (33 PSI). The specific tire data is as follows:

Tire	Measured Pressure	Maximum Pressure	Tread Depth	Restricted	Damage
LF	6.9 kPa (1.0 PSI)	351.6 kPa (51.0 PSI)	5.6 mm (7/32”)	No	Minor sidewall damage
LR	186.2 kPa (27.0 PSI)	351.6 kPa (51.0 PSI)	6.4 mm (8/32”)	No	None
RF	0.0 kPa	351.6 kPa (51.0 PSI)	5.6 mm (7/32”)	No	Minor sidewall damage
RR	165.5 kPa (24.0 PSI)	351.6 kPa (51.0 PSI)	6.4 mm (8/32”)	No	None

The front seating positions were configured with leather-trimmed, 10-way adjustable, power bucket seats with folding backs, heat, and memory settings. Both front seats were configured with four-way adjustable head restraints, which were in the full-down position at the time of the inspection. The driver’s seat was adjusted to 15.2 cm (6.0”) rear of the full-forward track position and 7.6 cm (3.0”) forward of the full-rear track position at the time of the inspection. The front right seat was adjusted to the full-rear position. The rear seating positions were configured with a two-person bench seat with adjustable head restraints.

CRASH SITE

This single vehicle crash occurred during the nighttime hours of July 2003 in the state of Florida. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The roadway was configured with three travel lanes in each direction that were separated by a curbed grassy median and bordered by 15 cm (6”) concrete curbs. Multiple trees were present on the median. The median narrowed north of the crash scene to accommodate a left turn lane adjacent to the inboard travel lane, which led to a left turn channel through the median. A tree that measured 45.7 cm (18.0”) in diameter was located in the center of the south median adjacent to the left turn channel. The roadside environment consisted of commercial businesses and the posted speed limit was 72 km/h (45 mph). The scene schematic is included as **Figure 10** of this report.

CRASH SEQUENCE

Pre-Crash

The 52-year-old male driver was operating the Lexus in the inboard southbound lane of the divided roadway. The police estimated pre-impact speed was 89 km/h (55 mph), and the driver exhibited signs of alcohol intoxication. The EDR-reported pre-crash speed was 57.9 km/h (36.0 mph) five seconds before impact and 56.0 km/h (34.8 mph) one second before impact. The driver stated to police that he looked away from the road in an attempt to locate a cellular telephone that was in the vehicle. He relinquished control of the Lexus and drifted into the left turn lane on approach to the left turn channel in the median (**Figure 2**). The driver did not attempt any avoidance maneuvers prior to the crash.



Figure 2. Southbound approach for the Lexus SC430

Crash

The vehicle traveled in a straight direction across the left turn channel (**Figure 3**) and struck the concrete curb face of the median on the south aspect of the channel. The bottom aspect of the bumper fascia struck the curb as the Lexus traveled onto the median. Due to the angle of the curb, the right front tire struck the curb and the Lexus rotated slightly clockwise (CW) and both wheels traveled over the curb as the Lexus continued onto the median. The front center aspect of the Lexus struck the tree that measured 45.7 cm (18.0”) in diameter located in the center of the median. The impact resulted in severe damage to the Lexus and was sufficient to deploy the driver’s frontal air bag and driver’s retractor-mounted safety belt pretensioner. The damage algorithm of the WinSMASH program computed a total delta-V of 43.0 km/h (26.7 mph) for the impact with the tree. The EDR reported a 0.5 km/h (0.3 mph) delta-V for the crash, which was not consistent with the reconstruction. The EDR output is summarized in the EDR section of this report. The Lexus rotated slightly in a CW direction around the tree and came to rest against the tree.



Figure 3. Close-up of concrete curb and struck tree

Post-Crash

It was not known how the driver of the Lexus exited the vehicle. He was transported by ambulance to a local hospital with police-reported possible injuries. His admission status was not reported.

VEHICLE DAMAGE

Exterior Damage – 2003 Lexus SC430

The 2003 Lexus SC430 sustained minor damage as a result of the curb impact. The bottom aspect of the bumper fascia sustained faint abrasions from contact with the concrete curb. The Collision Deformation Classification for the initial impact with the bottom of the bumper fascia was 12-FDLW-1. The damage to the front alloy wheels was minor, although the right front wheel sustained minor abrasions on the outer edge. Both front tires sustained minor sidewall damage as a result of the curb impact (**Figure 4**). The CDC's for the curb impact with the left and right front wheels were 12-FLWN-3 and 12-FRWN-3, respectively.



Figure 4. Left front wheel/tire showing minor sidewall damage

The Lexus sustained severe frontal damage as a result of the impact with the tree (**Figures 5 and 6**). The direct damage began 24.3 cm (13.5") right of the centerline and extended 77.5 cm (30.5") to the left along the bumper fascia and hood. Tree bark fragments and abrasions were present on the hood and front bumper fascia. The front bumper fascia was fractured and separated. The hood was crushed and buckled rearward and the bumper beam was displaced upward and crushed. The horizontal centerline of the front bumper beam was located 64.8 cm (25.5") above the ground at the vehicle centerline. The metal bumper beam exhibited an 8.9 cm (3.5") lateral tear on the face that was located 21.6 cm (8.5") inboard from the left corner of the beam. The maximum crush was located 9.5 cm (3.8") right of the centerline and measured 60.4 cm (23.8"). The combined direct and induced damage involved the entire frontal width of the Lexus and measured 67.3 cm (26.5") across the front bumper beam. The frontal damage displaced the left front wheel slightly rearward, which resulted in a 2.0 cm (0.8") reduction of the left wheelbase. Both front fenders were displaced rearward and buckled at the rear aspects as a result of interaction with the forward aspects of the side doors as they were opened. Additional induced buckling was present on the forward aspect of the left rear quarter panel. The windshield was fractured from impact forces and holed on the top left aspect. Six crush



Figure 5. Frontal view of damaged Lexus



Figure 6. Overhead view of crushed bumper beam

measurements were documented along the front bumper beam and were as follows: C1 = 5.1 cm (2.0"), C2 = 57.2 cm (22.5"), C3 = 59.7 cm (23.5"), C4 = 57.5 cm (22.6"), C5 = 35.6 cm (14.0"), C6 = 9.5 cm (3.8"). The CDC for the frontal impact to the tree was: 12-FDEW-3.

Interior Damage – 2003 Lexus SC430

The Lexus SC430 sustained minor interior damage as a result of passenger compartment intrusion and occupant contact. The left and right toe pans intruded longitudinally 5.1 cm (2.0") and 1.3 cm (0.5"), respectively. The left and right instrument panels intruded 2.5 cm (1.0") and the center instrument panel intruded 3.8 cm (1.5") longitudinally.

The steering column was compressed forward and was completely separated from the shear capsules. The left shear capsule displacement measured 4.4 cm (1.8") and the right shear capsule displacement measured 5.1 cm (2.0").

As shown by **Figure 7**, the instrumentation located in the center instrument panel was displaced from crash forces. The trim panels on the center console were displaced and fractured. The rear view mirror was separated and the glove box door opened during the crash and was jammed in the open position by interior deformation. A small scuff from probable left knee contact was located on the knee bolster 6.4 cm (2.5") left of the steering column centerline and 20.3 cm (8.0") below the top aspect of the bolster. The scuff measured 2.5 cm (1.0") in width and 5.1 cm (2.0") in length. Two faint linear scuffs were present on the headliner above the driver's seating position. Both scuffs measured 3.8 cm (1.5") in length.



Figure 7. View of damaged instrument panel area

MANUAL RESTRAINT SYSTEMS – 2003 LEXUS SC430

The Lexus SC430 was equipped with manual 3-point lap and shoulder belts for each seating position. The driver's safety belt was configured with a sliding latch plate and Emergency Locking Retractor (ELR). The driver's safety belt (**Figure 8**) was restricted in the used position at the time of the vehicle inspection. The plastic latch plate cover was abraded as a result of the driver loading against the safety belt webbing, and the driver's shoulder belt guide exhibited minor abrasions. Stretch marks in the driver's safety belt webbing began 61.0 cm (24.0") above the anchor and extended 53.3 cm (21.0") upward along the webbing. Two diagonal creases in the webbing were located 70.5 cm (27.8") and 73.0 cm (28.8") from the anchor from latch plate



Figure 8. View of restricted driver's safety belt

The front right passenger seating position and both rear seating positions were equipped with manual 3-point lap and shoulder belts that were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).

Both front seat backs were equipped with leather straps on the upper outboard aspects that were utilized as shoulder belt positioning devices. The straps were configured with metal snap tabs on the outboard aspects but were not in use at the time of the crash. Similar positioning devices were present on the inboard aspects of the rear seat backs for safety belt stowage, and were vertically centered on the seat backs.

ADVANCED OCCUPANT PROTECTION SYSTEM (AOPS)

Frontal Air Bag System – 2003 Lexus SC 430

The 2003 Lexus SC430 was equipped with an AOPS that included dual-stage frontal air bags, retractor-mounted safety belt pretensioners, an EDR, and an occupant presence detection system in the front right passenger seat. Although the system was not Certified Advanced 208-Compliant, it did detect occupant presence but could not differentiate weight variation in the seat. Per Toyota, the system worked in conjunction with the belt minder for the front right position. The system was designed to suppress the front right passenger's air bag if the front right seat was unoccupied. The EDR was retrieved by the SCI investigator from the Lexus and forwarded to Toyota by NHTSA for analysis.

The driver's frontal air bag deployed as a result of the frontal impact with the tree. The air bag (**Figure 9**) deployed from the center of the steering wheel that was configured with a triangular cover flap configuration with a horizontal tear seam that measured 14.9 cm (5.9") in width. The top cover flap measured 7.6 cm (3.0") in height and the contoured symmetrical bottom flaps measured 5.1 cm (2.0") in height. The air bag measured 66.0 cm (26.0") in diameter. Faint vinyl linear transfers were present on the left aspect of the air bag face from the expansion of the air bag. The transfers began 17.8 cm (7.0") left of the vertical centerline and 1.9 cm (0.8") below the horizontal centerline and measured 3.8 cm (1.5") in width and 12.1 cm (4.8") in height. A 1.3 cm (0.5") diameter puncture was located on the lower left quadrant of the air bag. It was located 18.4 cm (7.3") left of the vertical centerline and 8.3 cm (3.3") below the horizontal centerline. Additional expansion-related linear transfers were present on the lower right quadrant of the rear panel of the air bag along the circumferential seam. The transfers measured 14.0 cm (5.5") in length and extended 1.9 cm (0.8") in depth from the seam.



The Lexus was equipped with retractor-mounted safety belt pretensioners for the driver and front right passenger positions. The driver’s safety belt pretensioner fired as a result of the frontal impact.

The front right passenger’s air bag did not deploy in this crash. The Lexus was equipped with an occupant sensing system in the front right seat that suppressed the front right passenger’s air bag if the seat was unoccupied.

Side Impact Air Bag System – 2003 Lexus SC430

The Lexus SC430 was equipped with seat back-mounted side impact air bags for the driver and front right passenger positions. The side impact air bag system did not deploy as a result of this crash.

Event Data Recorder (EDR) – 2003 Lexus SC430

The EDR was downloaded by Toyota and the resulting output was forwarded to the General Dynamics SCI team by NHTSA. The output reported a dual stage air bag deployment for the driver at 126 milliseconds, and confirmed the non-deployment status of the front right passenger’s air bag. The EDR output is summarized as follows:

Belt Switch Status Driver	Belted
Belt Switch Status Passenger	Unbelted
Deployment Time	126 ms
Occupant Detection	Unknown
Deployment Stage Driver	Hi
Deployment Stage Passenger	Not Fired
Diagnostic	Not Detected
Lamp On Term	0 minutes
Ignition Cycles	0 times

The EDR output also reported five seconds of pre-crash data, with an additional data point captured at 0.1 seconds pre-crash. Included in the output was speed, engine RPM’s, Accelerator position, and brake position as follows:

Time	Speed	Engine	Accelerator	Brake
-5.0	36.0	1600	Off	Off
-4.0	36.0	1600	Off	Off
-3.0	36.0	1600	Off	Off
-2.0	36.0	1200	Middle	Off
-1.0	34.8	1200	Off	Off
-0.1	34.8	1200	Off	Off

Based on the reconstruction of the crash, the EDR-reported pre-crash vehicle speed and lack of pre-crash braking appear to be reasonable. However, the Engine RPM’s and Accelerator position may or may not be consistent with the crash scenario. The maximum EDR-reported delta-V was 0.5 km/h (0.3 mph) at 150 milliseconds (post-impact), which was not consistent with the crash

dynamics. In addition, the EDR reported the time from a previous event to be 5100 milliseconds and the time from the last pre-crash data was 900 milliseconds.

OCCUPANT DEMOGRAPHICS – 2003 LEXUS SC430

Driver

Age/Sex:	52-year-old/Male
Height:	Not reported
Weight:	Not reported
Seat Track Position:	15.2 cm (6.0”) rear of full-forward and 7.6 cm (3.0”) forward of full-rear
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a local hospital but his admission status was not reported

Driver Kinematics

The 52-year-old male driver of the Lexus was presumed to have been seated in an upright posture. He was restrained by the manual 3-point lap and shoulder belt, evidenced by the firing of the retractor-mounted pretensioner and loading evidence on the webbing. The driver initiated a slight forward and lateral trajectory as the front wheels of the Lexus impacted and overrode the concrete curb. At impact with the tree, the driver’s air bag deployed and the driver’s safety belt pretensioner fired. The driver initiated a forward trajectory and loaded the manual restraint. He loaded the deployed air bag, which mitigated additional contact with the steering wheel. His knees struck the knee bolster, evidenced by a scuff on the left aspect of the bolster. The longitudinal intrusion of the instrument panel combined with the driver’s loading against the deployed driver’s air bag resulted in the compression of the steering column, evidenced by the complete separation of both shear capsules. The driver rebounded rearward and may have been redirected slightly as the vehicle rotated around the tree and came to rest. It was not known how the driver exited the vehicle. He was transported by ambulance to a local hospital for police-reported possible C-level injuries. His admission status was not reported.

SCI
Case No. CA03-044
State of Florida
July 2003



Scale: 1cm = 2.5 m

Vehicle: 2003 Lexus SC430

Posted Speed Limit: 72 km/h (45 mph)

Commercial Business
Driveway

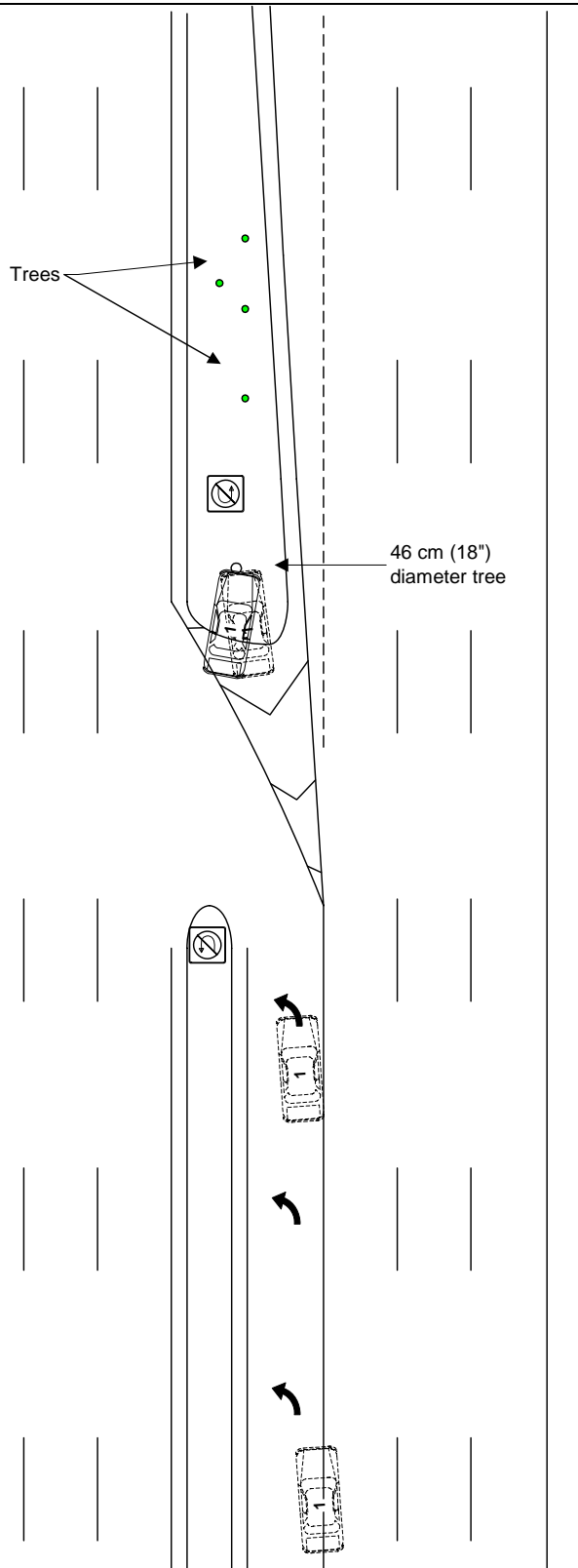


Figure 10. Scene schematic