

CRASH DATA RESEARCH CENTER

Calspan Corporation
Buffalo, NY 14225

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

CASE NO: CA04-042

VEHICLE: 2004 LEXUS ES 330

LOCATION: TENNESSEE

CRASH DATE: AUGUST 2004

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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

<i>1. Report No.</i> CA04-042	<i>2. Government Accession No.</i>	<i>3. Recipient's Catalog No.</i>	
<i>4. Title and Subtitle</i> Calspan On-Site Certified Advanced 208-Compliant Vehicle Crash Investigation Vehicle: 2004 Lexus ES 330 Location: State of Tennessee		<i>5. Report Date:</i> December 2005	
		<i>6. Performing Organization Code</i>	
<i>7. Author(s)</i> Crash Data Research Center		<i>8. Performing Organization Report No.</i>	
<i>9. Performing Organization Name and Address</i> Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		<i>10. Work Unit No.</i> C00410.0000.0239	
		<i>11. Contract or Grant No.</i> DTNH22-01-C-17002	
<i>12. Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		<i>13. Type of Report and Period Covered</i> Technical Report Crash Date: August 2004	
		<i>14. Sponsoring Agency Code</i>	
<i>15. Supplementary Note</i> This on-site investigative effort focused on the performance of Certified Advanced 208-Compliant safety system that was present in a 2004 Lexus ES 330.			
<i>16. Abstract</i> This on-site investigative effort focused on the performance of Certified Advanced 208-Compliant safety system that was present in a 2004 Lexus ES 330. The manufacturer of this vehicle has certified that this 2004 Lexus ES 330 meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Lexus was equipped with multi-stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant presence system, and an Event Data Recorder (EDR). The Lexus was also equipped with side impact air bags and inflatable curtains, which did not deploy in this crash. The Lexus was involved in a run-off-road crash with a concrete light pole that was sufficient to deploy the driver's frontal air bag. An 83-year-old female driver of the Lexus ES 330 was operating the vehicle westbound on the outboard lane of a local four-lane roadway. The driver swerved to the right to avoid a non-contact vehicle that encroached into the outboard lane from the inboard westbound lane. The Lexus departed the right roadside and the front right aspect struck the concrete light pole. The impact was sufficient to fracture the light pole and deploy the driver's air bag and driver's seat belt pretensioner. The front right seat was not occupied; therefore the front right air bag was suppressed. The driver sustained self-reported chest contusions but did not receive medical treatment. The EDR was retrieved from the vehicle during the SCI inspection and was forwarded to Toyota by NHTSA for analysis. The data output is included in the report.			
<i>17. Key Words</i> Certified Advanced 208-Compliant occupant protection Driver air bag deployment		<i>18. Distribution Statement</i> General Public	
<i>19. Security Classif. (of this report)</i> Unclassified	<i>20. Security Classif. (of this page)</i> Unclassified	<i>21. No. of Pages</i> 9	<i>22. Price</i>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	1
VEHICLE DATA – 2004 LEXUS ES 330	1
CRASH SITE	3
CRASH SEQUENCE	3
PRE-CRASH	3
CRASH	4
POST-CRASH	4
VEHICLE DAMAGE.....	4
EXTERIOR DAMAGE – 2003 LEXUS ES 330	4
INTERIOR DAMAGE – 2004 LEXUS ES 330	5
MANUAL RESTRAINTS - 2004 LEXUS ES 330	5
CERTIFIED ADVANCED-208 COMPLIANT SAFETY SYSTEM.....	6
FRONTAL AIR BAG SYSTEM – 2004 LEXUS ES 330	6
OCCUPANT SENSING SYSTEM – 2004 LEXUS ES 330.....	7
EVENT DATA RECORDER (EDR) – 2004 LEXUS ES 330	7
OCCUPANT DEMOGRAPHICS	8
DRIVER.....	8
DRIVER INJURIES.....	8
DRIVER KINEMATICS.....	8
FIGURE 12. SCENE SCHEMATIC	9

**CALSPAN ON-SITE CERTIFIED ADVANCED 208-COMPLIANT VEHICLE CRASH
INVESTIGATION
CASE NO.: CA04-042
LOCATION: STATE OF TENNESSEE
VEHICLE: 2004 LEXUS ES 330
CRASH DATE: AUGUST 2004**

BACKGROUND

This on-site investigative effort focused on the performance of Certified Advanced 208-Compliant safety system that was present in a 2004 Lexus ES 330. The manufacturer of this vehicle has certified that this 2004 Lexus ES 330 meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. The Lexus was equipped with multi-stage frontal air bags for the driver and front right passenger positions, seat track positioning sensors, a front right occupant presence system, and an Event Data Recorder (EDR). The Lexus was also equipped with side impact air bags and inflatable curtains, which did not deploy in this crash. The Lexus (**Figure 1**) was involved in a run-off-road crash with a concrete light



Figure 1. Damaged 2004 Lexus ES 330

pole that was sufficient to deploy the driver's frontal air bag. An 83-year-old female driver of the Lexus ES 330 was operating the vehicle westbound on the outboard lane of a local four-lane roadway. The driver swerved to the right to avoid a non-contact vehicle that encroached into the outboard lane from the inboard westbound lane. The Lexus departed the right roadside and the front right aspect struck the concrete light pole. The impact was sufficient to fracture the light pole and deploy the driver's air bag and driver's seat belt pretensioner. The front right seat was not occupied; therefore the front right was suppressed. The driver sustained self-reported chest contusions but did not receive medical treatment. The EDR was retrieved from the vehicle during the SCI inspection and was forwarded to Toyota by NHTSA for analysis. The data output is included in the report.

This crash was identified through a list of claims from an insurance company that identified Certified Advanced 208-Compliant vehicles that had been involved in crashes. The list was forwarded to the Calspan Special Crash Investigations team for follow-up and location of the vehicle. The Lexus ES 330 was located and cooperation was established with the insurance adjuster. An on-site investigation was assigned to the Calspan SCI team on October 6, 2004 due to the presence of the Certified Advanced 208-Compliant system.

SUMMARY

Vehicle Data – 2004 Lexus ES 330

The 2004 Lexus ES 330 was identified by the Vehicle Identification Number (VIN): JTHBA30G045 (production sequence omitted). The vehicle's electronic odometer read 2,713 km (1,686 miles) at the time of the SCI vehicle inspection. The vehicle was a four-door sedan that

was equipped with a 3.3 liter, V6 engine, with an Electronic Throttle Control System. The ES 330 was also configured with a five-speed automatic transmission, front wheel drive, four-channel, four sensor Anti-lock Brakes and the Brake Assist system. The Brake Assist system was designed to determine if a driver was attempting emergency braking and, if the driver had not applied sufficient braking force to activate the anti-lock brake system, it applied maximum braking pressure until pedal pressure was released. An Electronic Brakeforce Distribution (EBD) feature optimized braking pressure at each wheel to ensure stability during hard braking and cornering. The Lexus was also equipped with Vehicle Stability Control (VSC), which detected and helped to correct loss of lateral traction during cornering. The system automatically reduced the throttle and applied the brakes in response to traction loss. The VSC system integrated traction control (TRAC) to help limit rear wheel spin on slippery road surfaces. The ES 330 was also configured with engine-speed-sensing, progressive power-assisted steering and a tilt steering wheel.

The Lexus ES 330 was equipped with Bridgestone Turanza P215/60R16 tires on OEM alloy wheels. The manufacturer’s recommended tire pressure was 200 kpa (29 psi). The specific tire information at the time of the SCI inspection was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	189.6 kPa (27.5 PSI)	7.9 mm (10/32”)	No	None
LR	189.6 kPa (27.5 PSI)	7.9 mm (10/32”)	No	None
RF	186.2 kPa (27.0 PSI)	7.9 mm (10/32”)	No	None
RR	196.5 kPa (28.5 PSI)	7.9 mm (10/32”)	No	None

The seating in the Lexus ES 330 was configured with leather-trimmed bucket seats for the driver and front right passenger positions. The driver’s seat was configured with a 10-function, two-position memory system, heat controls, and an adjustable head restraint. At the time of the vehicle inspection, the driver’s seat track was in the full-rear position, and the driver’s head restraint was in the full-down position. The driver stated that the pre-crash location of the driver’s seat was probably near the mid-track position due to her short stature. The seat back was reclined 25 degrees, the forward edge of the seat cushion was vertically adjusted 29.2 cm (11.5”) above the floor and the rearward seat cushion angle was 20 degrees from horizontal. The tilt steering wheel was positioned in the fourth position from the top, of six total positions.

The front right passenger’s seat was configured with an 8-function power adjustment, heat controls, and an adjustable head restraint. The front right passenger’s head restraint was in the full-down position, the seat back was reclined 20 degrees, the forward edge of the seat cushion was vertically adjusted 25.4 cm (10.0”) above the floor, and the rearward seat cushion angle was 20 degrees from horizontal.

The rear seating positions were configured with a leather-trimmed bench seat with adjustable head restraints for each seating position that were all in the full-down positions. A center fold-

down armrest was present in the seat back with a pass-through to the trunk located behind the armrest.

Crash Site

This single-vehicle crash occurred during the daylight hours of August 2004 in the state of Tennessee. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The crash occurred on the north roadside of a four-lane east/west municipal roadway approximately 100 m (328') east of a four-leg intersection. The struck pole was located 0.8 m (2.6') from the road edge between two driveways to commercial establishments (**Figure 2**). The struck concrete light pole measured 22.9 cm (9.0") square at the base and exhibited a slight vertical taper. The distance between the driveways measured 4.2 m (13.8'). The east/west roadway consisted of two travel lanes in each direction separated by a painted center left turn lane.



Figure 2. View of crash site and concrete light pole

In the area of the crash, the westbound travel lanes widened to create two inboard left turn lanes at the mouth of the intersection in addition to the two 'through' travel lanes. Concrete curbs bordered the roadway; however, the north roadside curb height decreased on approach to the intersection, and was negligible at the crash location. Additional concrete light poles were present on the roadside beyond the crash location. The roadside environment consisted of commercial properties and parking lots, and the posted speed limit was 56 km/h (35 mph). The scene schematic is included as **Figure 12** at the end of this narrative report.

Crash Sequence

Pre-Crash

The 83-year-old female driver was operating the 2004 Lexus ES 330 in a westbound direction on the municipal roadway. She stated that her pre-impact speed was approximately 48 km/h (30 mph) and there were no distractions in the vehicle. The Lexus was traveling in the outboard westbound lane and the driver maintained the outboard lane as the travel lanes began to widen on approach to the intersection (**Figure 3**).



Figure 3. Westbound approach for the Lexus ES 330

A non-contact vehicle traveling in the inboard lane passed the Lexus and initiated a rapid lane change to the outboard lane in front of the Lexus (**Figure 4**). According to the driver of the Lexus, the driver of the non-contact vehicle (NCV) immediately applied the brakes in front of the Lexus. She steered right in an attempt to turn into a driveway of a commercial establishment on the roadside and avoid a collision with the NCV. The driver was unable to negotiate the driveway and the Lexus departed the right roadside slightly west of the driveway toward the concrete pole.



Figure 4. Area where NCV passed the Lexus

Crash

The front right aspect of the Lexus impacted the concrete utility pole. The impact resulted in moderate damage to the Lexus and was sufficient to deploy the driver's air bag and safety belt pretensioner. The barrier routine of the WinSMASH program computed a delta-V of 31.0 km/h (19.2 mph) based on the frontal crush profile across the bumper beam. The impact caused the concrete pole to fracture as the Lexus continued through the pole. Based on the direct contact abrasions to the left aspect of the bumper fascia, it appeared that as the pole fractured, a portion of the pole was displaced forward and to the right, which was struck by the front left corner of the bumper as the Lexus came to rest, straddling the road edge. The luminaire was separated from the pole during the event and struck the left rear aspect of the vehicle roof as it fell. The backlight and left rear window were shattered by this impact and lens fragments from the luminaire were found in the rear seat area of the Lexus.

Post-Crash

Immediately following the crash, the driver of the Lexus exited the vehicle under her own power. She sustained self-reported chest contusions but refused medical treatment at the scene and was not transported to a medical facility. The driver of the NCV did not stop at the crash site.

Vehicle Damage

Exterior Damage – 2003 Lexus ES 330

The 2003 Lexus ES 330 sustained moderate frontal damage as a result of the impact with the concrete light pole (**Figures 5 and 6**). The direct damage from the initial impact began 31.1 cm (12.3") right of the centerline and extended 35.6 cm (14.0") to the right. The front bumper fascia was fractured on the right aspect and was partially separated. Direct contact abrasions and concrete transfers were present on the right aspect of the hood, which was crushed and buckled rearward. The bumper beam sustained longitudinal crush, as did the upper and lower radiator supports. The maximum crush was located 31.1 cm (12.3") right of center and measured 40.6 cm (16.0").



Figure 5. Frontal view of damage

The combined direct and induced damage measured 94.6 cm (37.3") across the front bumper beam. The right front fender was displaced slightly rearward. Six crush measurements were documented along the front bumper beam and were as follows: C1 = 0.0 cm, C2 = 7.0 cm (2.8"), C3 = 18.1 cm (7.1"), C4 = 30.8 cm (12.1"), C5 = 40.0 cm (15.8"), C6 = 17.1 cm (6.8"). Six additional crush measurements were documented along the upper radiator support, but due to the lack of override were not included in the crush profile. The Collision Deformation Classification (CDC) for the initial impact with the concrete light pole was 12-FZEN-2



Figure 6. Overhead view of frontal crush

The Lexus sustained moderate damage as a result of the impact with the displaced luminaire. The left rear aspect of the roof sustained shallow punctures in the paint and the maximum vertical crush was located 27.9 cm (11.0") forward of the backlight header and 27.3 cm (10.8") inboard of the left roof side rail (**Figure 7**). The maximum crush measured 1.3 cm (0.5"). The combined direct and induced damage began at the backlight header, extended forward 55.9 cm (22.0"), began at the left roof side rail and extended laterally 54.6 cm (21.5"). The backlight glazing and left rear door glazing disintegrated as a result of the luminaire impact. The tempered glass sunroof was not damaged by this impact. The CDC for the roof impact was 00-TPYW-2.



Figure 7. Overhead view of left rear roof damage

Interior Damage – 2004 Lexus ES 330

The 2004 Lexus ES 330 sustained minor interior damage as a result of the crash. There was no passenger compartment intrusion. Occupant contact was limited to the driver's air bag and safety belt webbing.

Manual Restraints - 2004 Lexus ES 330

The 2004 Lexus ES 330 was configured with manual 3-point lap and shoulder belts for all five seating positions. The driver's safety belt was configured with a sliding latch plate, Emergency Locking Retractor (ELR), and an adjustable D-ring that was located in the full-down position at the time of the vehicle inspection. The driver's safety belt (**Figure 8**) was restricted in the used position as a result of the retractor pretensioner actuation. The total exposed webbing measured 177.2 cm (69.8") between the lower anchor and the D-ring. The driver's plastic-covered latch plate exhibited moderate abrasions as a



Figure 8. Driver's safety belt

result of the driver's loading to the safety belt. The driver's D-ring also sustained abrasions from the loading to the safety belt. Minor deformation was present on the webbing from driver loading. The deformation began 62.9 cm (24.8") above the lower anchor and extended 91.4 cm (36.0") up the webbing.

The remaining safety belts were configured with sliding latch plates and switchable ELR/Automatic Locking Retractors (ALR).

Certified Advanced 208-Compliant Safety System

Frontal Air Bag System – 2004 Lexus ES 330

The 2004 Lexus ES 330 was equipped with a Certified Advanced 208-Compliant safety system that included multi-stage air bags for the driver and front right passenger positions, safety belt pretensioners, seat track positioning sensors, a front right occupant presence detection system, and an Event Data Recorder (EDR). The manufacturer of this vehicle has certified that this 2004 Lexus ES 330 meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. An indicator light was present on the lower center instrument panel above the HVAC controls, which indicated the "on/off" status of the front right passenger's air bag. During the vehicle inspection, the ignition key was turned to the "on" position and the status light for the front right passenger's air bag did not illuminate. The air bag warning light on the instrument panel was continually illuminated while the key was turned to the "on" position.

The driver's air bag (**Figure 9**) deployed from the center of the steering wheel that was configured with a triangular cover flap design 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 in its deployed state. Two circular ports that measured 2.5 cm (1.0") in diameter vented the air bag. The vent ports were located 7.6 cm (3.0") from the peripheral seam at the 1 and 11 o'clock positions on the top rear aspect of the air bag. Two internal straps that measured 12.7 cm (5.0") in width and were located at the 3 and 9 o'clock positions tethered the air bag.



Figure 9. Deployed driver's air bag

Interior inspection of the driver's air bag revealed small fragments of grey particulate that were fused to the interior aspect of the air bag fabric. **Figures 10 and 11** are views through the vent port showing the grey deposits on the interior aspect of the air bag fabric and below the inflator. There was no evidence to suggest that any of the grey deposits were exhausted through the vent ports, and the integrity of the air bag was not compromised.



Figure 10. View of grey deposits on interior of air bag fabric



Figure 11. Bottom aspect of the inflator and grey deposits

Makeup transfers were present on the face of the driver's air bag from contact with the driver's face. The transfer began 0.6 cm (0.3") left of the vertical centerline and 5.7 cm (2.3") above the horizontal centerline. The makeup transfer extended 6.4 cm (2.5") to the right and 12.1 cm (4.8") downward. A small lipstick transfer was present on the bottom aspect of the makeup transfer and was located 2.5 cm (1.0") right of the vertical centerline and 6.0 cm (2.4") below the horizontal centerline. The lipstick transfer measured 1.3 cm (0.5") in height and width. The transfers did not exhibit any smearing and suggested that the driver's face contacted the air bag after it was fully inflated. The driver's retractor-mounted safety belt pretensioner fired as a result of the frontal impact, in conjunction with the driver's air bag.

The front right air bag was located on the upper right instrument panel. The front right air bag did not deploy in the crash, as the front right seat was unoccupied. The front right safety belt pretensioner did not fire in the crash.

Occupant Sensing System – 2004 Lexus ES 330

The Certified Advanced 208-Compliant (CAC) safety system was configured with a weight sensor in the front right seat cushion. The system was designed to detect occupant presence and suppress the front right passenger's air bag if it detected a weight consistent with a child seat, a booster seat, or a child sitting in the front seat, or it if determined that the front seat was not occupied. A light on the lower center instrument panel above the HVAC controls was designed to confirm the air bag on/off status. Since the front right seat was not occupied and the safety belt buckle was not engaged, the CAC system suppressed the front right passenger's air bag. Both front seat positions were also equipped with seat track position sensors, which adjusted the air bag deployment level if the seat was in a forward track position.

Event Data Recorder (EDR) – 2004 Lexus ES 330

The Event Data Recorder (EDR) was retrieved from the 2004 Lexus ES 330 by the SCI investigator during the vehicle inspection. It should be noted that permission to retrieve the EDR was provided by the insurance claims representative, who witnessed the removal. The EDR was forwarded to Toyota by NHTSA for analysis. The data indicated that a deployment command for the driver's air bag and belt retractor was received at two milliseconds of Algorithm Enable

(AE), and was a Stage Two, Hi deployment command. The EDR recorded velocity changes at intervals from 10–150 milliseconds post-AE and peaked at a 25.3 km/h (15.7 mph) at 150 milliseconds. The data further recorded that the driver was belted. The front right passenger seat was unoccupied and the EDR recorded a freeze signal and did not deploy either the front right air bag or belt retractor pretensioner.

Occupant Demographics

Driver

Age/Sex: 83-year-old/Female
 Height: 155 cm (61")
 Weight: 54 kg (119 lb)
 Seat Track Position: Probably mid-track (per driver)
 Manual Restraint Use: Manual 3-point lap and shoulder belt
 Usage Source: Vehicle inspection
 Eyewear: None
 Type of Medical Treatment: Refused medical treatment

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Probable Injury Mechanism
Chest contusions, NFS	Minor (490402.1,9)	Safety belt webbing

Injury source: Driver interview

Driver Kinematics

The 83-year-old female driver of the Lexus ES 330 was seated in an upright posture. She was restrained by the manual 3-point lap and shoulder belt. The driver could not recall the position of the driver's seat track, although she estimated that it was near the mid-track position due to her short stature. Given the driver's height and weight compared with the length of exposed safety belt webbing, her estimated seat track position was reasonable.

At impact with the concrete light pole, the safety belt pretensioner fired and the driver's air bag deployed. The driver initiated a forward trajectory and loaded the safety belt. She sustained self-reported chest contusions as a probable result of loading to the safety belt webbing. Her face contacted the deployed air bag, evidenced by makeup and lipstick transfers on the center of the air bag face. She was probably minimally displaced as the front of the Lexus struck the fragments of the concrete pole with the front left aspect. She remained in position as the luminare fell on the vehicle's roof, and as the vehicle came to rest straddling the road edge. The driver exited the vehicle under her own power. She refused medical treatment and was not transported to a medical facility.

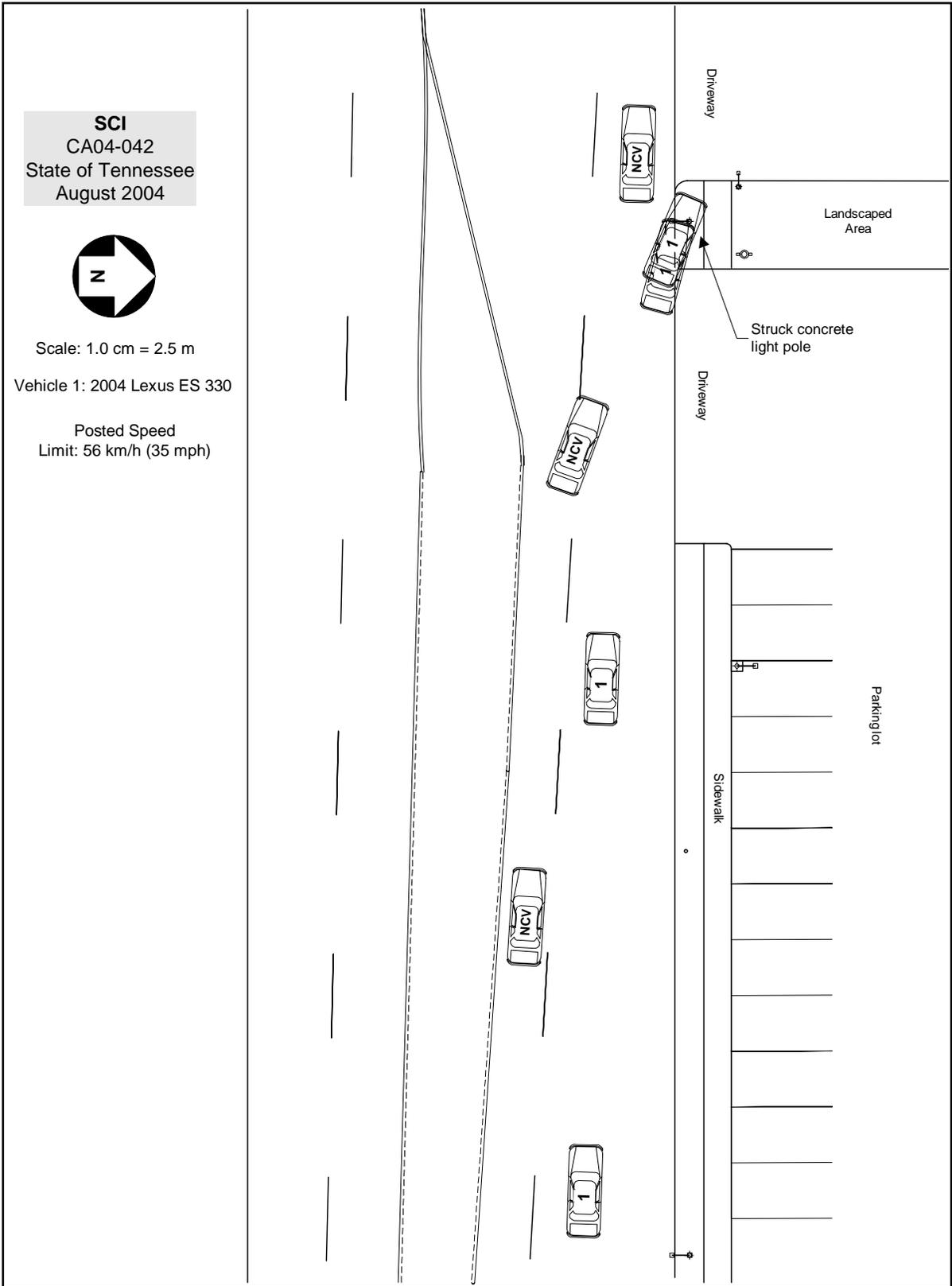


Figure 12. Scene Schematic