CRASH DATA RESEARCH CENTER

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

CASE NO: CA04-034

VEHICLE: 2004 LEXUS ES 330

LOCATION: CONNECTICUT

CRASH DATE: JUNE 2004

Contract No. DTNH22-01-C-17002

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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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LOCATION: STATE OF CONNECTICUT
VEHICLE: 2004 LEXUS ES 330
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BACKGROUND

This on-site investigation focused on the performance of the 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 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 Lexus was also equipped with side impact air bags and side impact inflatable curtains, which did not deploy in this crash. The Lexus ES 330 **(Figure 1)** was occupied by a 42-year-old male driver. The driver was operating the vehicle under the influence of alcohol and at a high rate of speed on a four-lane divided highway. The driver attempted a lane change maneuver from the inboard lane and struck the rear aspect of a 1989 Mazda 929 traveling in the outboard lane. The impact was sufficient to deploy the frontal air bag system in the Lexus. Since the front right seat was unoccupied, the front right passenger's air bag did not deploy. The Lexus was deflected onto the outboard shoulder and struck a three-strand cable guardrail. The Lexus continued in a forward direction against the guardrail to final rest. The driver of the Lexus did not sustain injury and did not receive medical treatment.

Figure 1. Damaged 2004 Lexus ES 330

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 vehicles. The Lexus ES 330 was located and cooperation was established with the insurance adjuster. An on-site investigation was assigned to the General Dynamics SCI team on July 26, 2004 due to the presence of the Certified Advanced 208-Compliant system. A Police Accident Report (PAR) was obtained from the investigating agency, and the Mazda 929 was subsequently located at a local tow yard.

VEHICLE DATA – 2004 LEXUS ES 330

The 2004 Lexus ES 330 was identified by the Vehicle Identification Number (VIN): JTHBA30G545 (production sequence omitted). The vehicle was a four-door sedan equipped with a 3.3 liter, V6 engine, and 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 detects and helps to correct loss of stability during cornering. The system automatically applies braking to individual wheels, reduces the throttle, or applies a combination of these actions to correct the loss of yaw stability (under steer or over steer). The VSC system integrated traction control (TRAC) to help limit front 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 Potenza 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 investigation was as follows:

Position	Measured Pressure	Measured Tread Depth	Restricted	Damage
LF	0.0 kPa	5.6 mm (7/32")	No	None
LR	237.9 kPa (34.5 PSI)	6.4 mm (8/32")	No	None
RF	231.0 kPa (33.5 PSI)	5.6 mm (7/32")	No	None
RR	231.0 kPa (33.5 PSI)	5.6 mm (7/32")	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 appeared to be in the full-rear position, and the driver's head restraint was positioned 3.2 cm (1.3") above the seat back. The seat back was reclined 20 degrees, the forward edge of the seat cushion was vertically located 26.7 cm (10.5") above the floor and the rearward seat cushion angle was 15 degrees from horizontal. The steering wheel was adjusted to the full-up position at the time of the vehicle inspection.

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 positioned 7.0 cm (2.8") above the top of the seat back, the seat back was reclined 25 degrees, the forward edge of the seat cushion was vertically located 29.2 cm (11.5") above the floor and the rearward seat cushion angle was 25 degrees from horizontal.

The rear seating positions were configured with a leather-trimmed bench seat with adjustable head restraints for each seating position. A center fold-down armrest was present in the seat back with a pass-through to the trunk located behind the armrest.

VEHICLE DATA – 1989 MAZDA 929

The 1989 Mazda 929 was identified by the VIN: JM1HC2217K0 (production sequence omitted). The vehicle was a four-door sedan that was equipped with a 3.0 liter, V6 engine, four-speed automatic transmission, power-assisted brakes, power steering, and a tilt steering wheel. The Mazda 929 was configured with Dunlop D60 A2 P205/60R15 tires. The manufacturer's label on the vehicle specified the tire size as P195/65R15, and the manufacturer's recommended tire pressure was 207 kpa (30 psi).

CRASH SITE

This two-vehicle crash occurred during the nighttime hours of June 2004 in the state of Connecticut. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The crash occurred on the northbound lanes of a four-lane divided highway. The north/south travel lanes were separated by an extended-height Jersey median barrier that was approximately 178 cm (70") in height. Both southbound travel lanes measured 3.7 m (12.0') in width and were bordered by asphalt shoulders and Continuous Shoulder Rumble Strips (CSRS). A three-strand cable guardrail was present on the outboard roadside supported by weak-post I-beams spaced on 3.8 m (12.5') centers **(Figure 2)**. The northbound travel lanes exhibited a slight right curve and a slight positive northbound grade at the crash site. The posted speed limit was 105 km/h (65 mph). Due to heavy traffic flow, the scene was not thoroughly documented. A scene schematic with estimated distances is included as **Figure 11** of this narrative report.

Figure 2. Close-up of three-strand cable guardrail (northbound roadside)

CRASH SEQUENCE

Pre-Crash

Police reported that the driver of the 2004 Lexus ES 330 was operating the vehicle under the influence of alcohol. His pre-crash speed was not known. He was operating the Lexus on the inboard northbound lane of the divided highway **(Figure 3)**. The 1989 Mazda 929 was traveling in the same direction on the outboard northbound lane ahead of the Lexus. The driver of the Lexus initiated a lane change maneuver to the outboard lane but did not detect the Mazda in the travel lane.

Figure 3. Northbound approach for both vehicles

Crash

The front aspect of the Lexus ES 330 impacted the rear aspect of the Mazda 929. The impact resulted in moderate damage to both vehicles and was sufficient to deploy the driver's air bag and safety belt pretensioner in the Lexus. The damage algorithm of the WinSMASH program computed a total delta-V of 22.0 km/h (13.7 mph) for the Lexus ES 330 and a total delta-V of 23.0 km/h (14.2 mph) for the Mazda 929 based on the respective crush profiles. The Event Data Recorder recorded a maximum delta-V of 20.4 km/h (12.7 mph) at 150 ms within the crash

events. The Mazda 929 was deflected slightly counterclockwise (CCW) and traveled in a tracking mode across the inboard lane and onto the inboard shoulder. According the police report, the Mazda came to rest on the inboard shoulder facing north. There was no physical evidence at the crash site to support final rest positions. The Lexus traveled in a tracking mode onto the outboard shoulder. The right front corner struck a three-strand cable guardrail system, which redirected the Lexus CCW as it engaged the guardrail. The engagement of the guardrail was sufficient to cause pocketing on the right front fender from contact with the cables. The Lexus continued in a tracking mode approximately 30 m (100') while the right side of the Lexus sideswiped the guardrail. The Lexus came to rest on the outboard northbound shoulder.

Post-Crash

The driver of the Mazda sustained a police-reported complaint of pain and was transported by ambulance to a local hospital for treatment. The driver of the Lexus did not sustain injury and did not receive medical treatment. It was not known how the occupants exited the vehicles.

VEHICLE DAMAGE

Exterior Damage – 2004 Lexus ES 330

The 2004 Lexus ES 330 sustained moderate frontal damage **(Figure 4)** as a result of the initial impact with the Mazda 929. The leading edge of the hood sustained abrasions and deformation as a result of direct contact with the Mazda. The direct contact damage on the hood began 48.3 cm (19.0") right of the centerline and extended 121.9 cm (48.0") laterally to the front left corner. The direct contact on the hood extended 38.1 cm (15.0") longitudinally from the leading edge. The bumper fascia was fractured and separated at the time of the vehicle inspection. The front bumper beam was crushed rearward and the maximum crush on the beam was located 4.4 cm (1.8") right of center and measured 30.8 cm (12.1"). The leading 27.9 cm (11.0") of the left frame rail was deflected inward 8.9 cm (3.5"). The combined direct and induced damage involved the entire frontal width of the Lexus and measured 121.9 cm (48.0") across the damaged front bumper beam. The hood was bucked upward and rearward and the upper radiator support was deformed as a result of engagement with the hood. Both front fenders sustained induced buckling. There was no reduction of the wheelbase and no induced damage from the initial impact rear of the A-pillars. Six crush measurements were documented across the front bumper beam and were as follows: C1 = 3.8 cm (1.5"), C2 = 13.3 cm (5.3"), C3 = 25.1 cm (9.9"), C4 = 27.6 cm (10.9"), C5 = 14.6 cm (5.8"), C6 = 0.0 cm. The Collision Deformation Classification (CDC) for the initial impact with the Mazda 929 was 12-FDEW-2.

Figure 4. Frontal damage to the 2004 Lexus ES 330

The Lexus sustained minor right side damage as a result of the guardrail impact. The direct damage began at the right front corner above the bumper and extended along the entire right side plane. Pocketing in the right front fender above the right front wheel was present from the initial engagement of the cables **(Figure 5)**. The pocketing of the fender measured 3.8 cm (1.5") in height and 9.5 cm (3.8") in depth at the leading aspect, and diminished to surface abrasions at the rear aspect. The pocketing began at the leading edge of the right front fender and extended 85.1 cm (33.5") to the leading edge of the right front door. There was no structural deformation present aft of the right front fender. Abrasions from the cable guardrail were present on the mid-door level of the right front door, right rear door, and the right rear quarter panel. A scuff mark was also present on the right sill below the right front door, which began at the leading edge of the sill and measured 83.8 cm (33.0") in length. The CDC for the guardrail impact was 12-FRES-9.

Figure 5. Right front fender damage from guardrail

Interior Damage – 2004 Lexus ES 330

The Lexus ES 330 sustained minor interior damage as a result of the crash. There was no intrusion of the passenger compartment. The windshield sustained a small focused fracture that was located 15.2 cm (6.0") left of the centerline and 33.7 cm (13.3") below the windshield header. The fracture **(Figure 6)** may have resulted from a fling of the driver's right hand into the windshield as a result of the driver's air bag deployment. There was no damage to the side glazing, backlight, or sunroof.

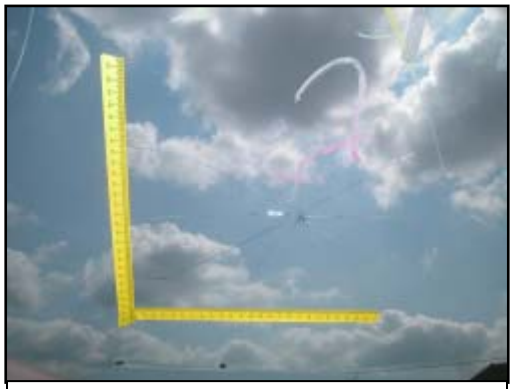

Figure 6. Close-up of windshield fracture

Exterior Damage – 1989 Mazda 929

The 1989 Mazda 929 sustained moderate rear damage as a result of the impact with the Lexus ES 330 **(Figure 7)**. The rear bumper fascia was partially separated and sustained abrasions and white paint transfers from direct contact with the Lexus. The direct contact damage began 64.8 cm (25.5") left of the centerline and extended 139.7 cm (55.0") to the rear right corner of the rear bumper. The bumper beam sustained longitudinal crush, and the maximum crush was located 6.4 cm (2.5") left of center and measured 18.0 cm (7.1"). The direct contact from the Lexus extended upward along the lower edge of the trunk.

Figure 7. View of damaged 1989 Mazda 929

The combined direct and induced damage involved the entire width of the rear bumper **(Figure 8)** and measured 152.4 cm (60.0”). Both rear quarter panels sustained induced buckling, more severe on the right side. Due to limited access to the rear plane as a result of the vehicle location, the reference line was established laterally across the trunk 60 cm (23.6”) rear of the undamaged rear axle, and the crush measurements documented accordingly across the rear bumper beam as follows: C1 = 7.8 cm (3.1”), C2 = 11.6 cm (4.6”), C3 = 14.2 cm (5.6”), C4 = 16.7 cm (6.6”), C5 = 14.8 cm (5.8”), C6 = 12.9 cm (5.1”). The CDC for the impact with the Lexus was 06-BDEW-2.

Figure 8. Lateral view from left along damaged rear bumper beam

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-up position at the time of the vehicle inspection. At the time of the vehicle inspection, the driver’s safety belt was restricted in the used position as a result of the retractor pretensioner actuation **(Figure 9)**. The total exposed webbing measured 191.8 cm (75.5”) between the lower anchor and the D-ring. The driver’s plastic-covered latch plate exhibited moderate abrasions as a result of the driver’s loading to the safety belt. The driver’s D-ring sustained abrasions from the loading to the safety belt, as well. Minor deformation was present on the webbing from driver loading. The deformation began 47.0 cm (18.5”) above the lower anchor and extended 95.3 cm (37.5”) up the webbing.

Figure 9. View of driver's safety belt

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.

The driver's air bag 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 **(Figure 10)** measured 66.0 cm (26.0") in diameter. The air bag was vented by two circular ports that measured 2.5 cm (1.0") in diameter. The vent ports were located 7.6 cm (3.0") from the circumferential seam at the 1 and 11 o'clock positions on the top rear aspect of the air bag. The air bag was tethered by two internal straps that measured 12.7 cm (5.0") in width and were located at the 3 and 9 o'clock positions of the air bag. There was no occupant contact evidence present on the air bag or module cover flaps.

Figure 10. Deployed driver's air bag

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 passenger's air bag was located on the upper right instrument panel. The front right passenger's air bag did not deploy in the crash, as the front right seat was unoccupied. The front right passenger's 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 automatically 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 empty. The air bag on/off status could be confirmed by a light on the lower center instrument panel above the HVAC controls. 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.

Side Impact Air Bags/Inflatable Curtains

The 2004 Lexus ES330 was equipped with side impact air bags for each front seating position. The side air bags were located in the outboard aspects of the front seat backs and provide torso protection. The side air bags did not deploy in this crash.

The 2004 Lexus ES330 was also equipped with side impact Inflatable Curtains (IC's). The IC's deploy downward from the roof side rails between the A- and C-pillars and provide head protection for the front and rear seat occupants. The IC's did not deploy in this crash.

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. The EDR was forwarded to Toyota from NHTSA for analysis. The results were received by the SCI team from NHTSA and detailed herein. The output indicated that a deployment command for the driver's airbag and belt retractor was received at 68 milliseconds within the crash events. The passenger side was unoccupied and subsequently received a freeze signal and did not deploy either system. The data further recorded the driver's belt status as belted. The EDR output is summarized below:

Belt Switch Status Driver	Belted
Belt Switch Status Passenger	Unbelted
Deployment Time	68 ms.
Occupant Detection	No Level
Deployment Stage Driver	Lo
Deployment Stage Passenger	Not Fired
Lamp on Term	0 Minutes
Ignition Cycles	0 Times

An error prevented the EDR from recording the five seconds of pre-crash data. The EDR output did contain data values for post-crash velocity in intervals between 10.0 to 150.0 milliseconds. The post-crash data output is summarized as follows:

Milliseconds (ms) – Post Crash	**Velocity Change**
10.0	.5
20.0	2.7
30.0	4
40.0	5.2
50.0	7
60.0	8.8
70.0	11.6
80.0	15.1
90.0	17.2
100.0	18.5
110.0	19.4
120.0	19.9
130.0	20.2
140.0	20.3
150.0	20.4

OCCUPANT DEMOGRAPHICS

Driver

Age/Sex:	42-year-old male
Height:	Not Reported
Weight:	Not Reported
Seat Track Position:	Full rear
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Vehicle inspection
Eyewear:	Unknown
Type of Medical Treatment:	Policed reported he did not sustain injury and did not receive medical treatment or transportation to a medical facility

Driver Kinematics

The 42-year-old driver of the Lexus ES 330 was presumed to have been seated in an upright posture, and was operating the Lexus under the influence of alcohol. He was restrained by the manual 3-point lap and shoulder belt. At impact with the Mazda, the safety belt pretensioner fired and the driver's air bag deployed. Based on the focused windshield fracture, the driver's right hand may have been deflected into the windshield as a result of the driver's air bag deployment. The driver initiated a forward trajectory and loaded the safety belt. His head contacted the deployed air bag, which mitigated contact with the steering wheel. The driver rebounded rearward as the Lexus departed the right roadside and struck the cable guardrail. At impact with the guardrail, the driver was displaced slightly forward and to the right but remained in position due to the use of the safety belt as the vehicle sideswiped the guardrail. He came to rest in the driver's seat as the Lexus came to rest on the roadside. It was not known how he exited the vehicle. Police reported that the driver did not sustain injury and was not transported to a medical facility.

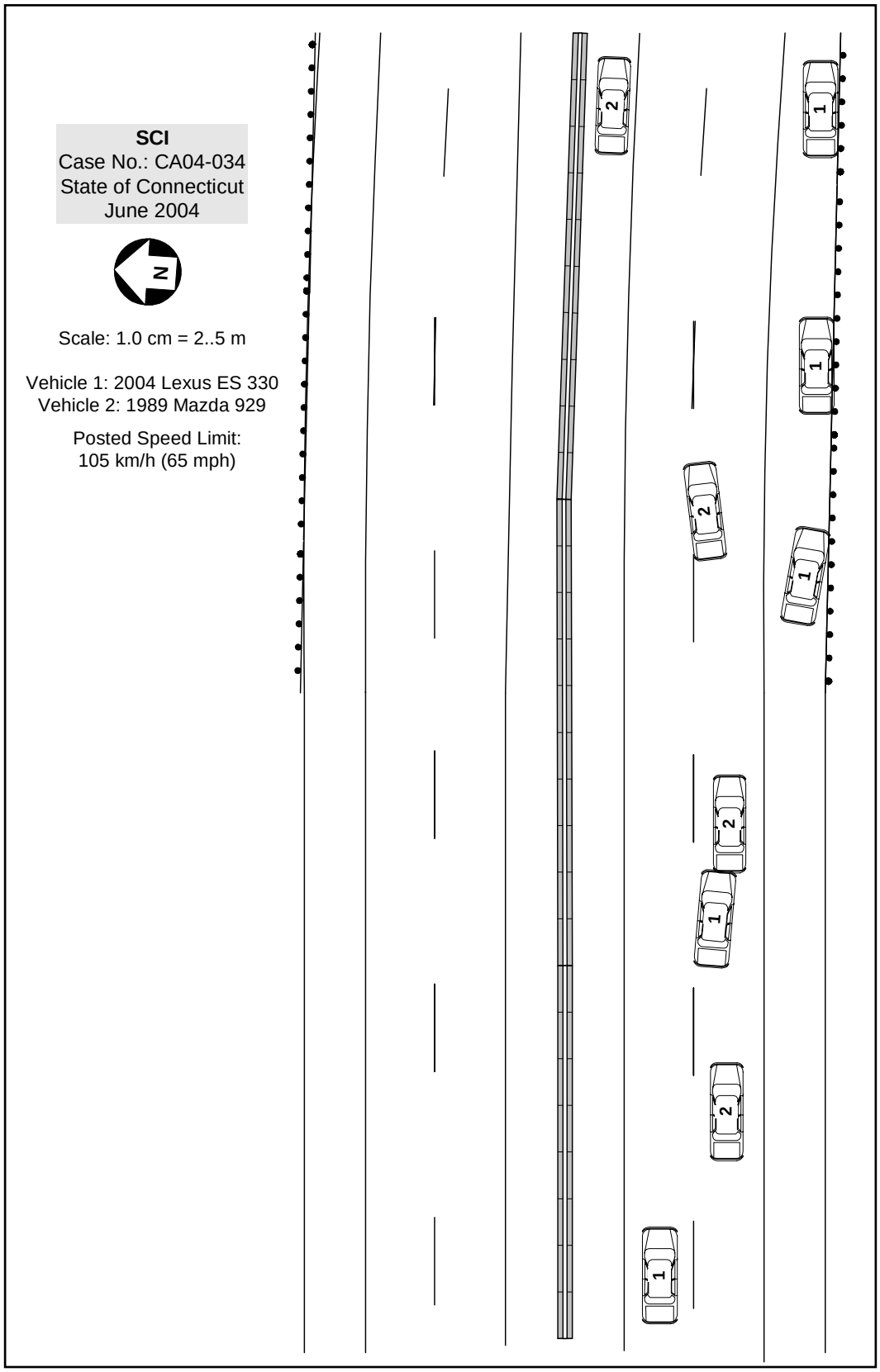

Figure 11. Approximated scene schematic