**TRANSPORTATION SCIENCES CENTER**
**ACCIDENT RESEARCH GROUP**

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# CALSPAN REMOTE DEPOWERED AIR BAG DEPLOYMENT INVESTIGATION

**CALSPAN CASE NO. CA97-40**

**VEHICLE - 1998 LINCOLN NAVIGATOR**

**LOCATION - STATE OF PENNSYLVANIA**

**CRASH DATE - OCTOBER, 1997**

Contract No. DTNH22-94-D-07058

Prepared for:

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

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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, be 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 of the involved vehicle(s) or their safety systems.

## TECHNICAL REPORT STANDARD TITLE PAGE

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| 16. *Abstract*<br>This remote investigation focused on a single vehicle crash that involved a 1998 Lincoln Navigator. The Lincoln was equipped with a Supplemental Restraint System (SRS) that consisted of depowered dual frontal air bags. The crash was initiated when the driver of the Lincoln lost control and departed the left side of the road. The vehicle traveled approximately 27 m ( 88 ft) through a field, down an embankment and into a small creek. The frontal plane of the vehicle struck several small trees and the opposing creek embankment. The vehicle then overturned coming to rest on its left side. The air bags deployed due to the impact with the opposing creek embankment.<br><br>The frontal plane of the Lincoln was damaged across its full width. The maximum measured deformation occurred at C1 and was 35 cm (14 in). The estimated delta V of the vehicle was 21.8 km/h (13.5 mph) calculated by the barrier model of the SMASH algorithm.<br><br>The 36 year old male driver of the Lincoln was the vehicle's sole occupant. He was not restrained by the vehicle's seat belt system. He sustained a laceration to the left side of the forehead as a result of contact with the windshield. | | | |
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**VEHICLE #1 - 1998 LINCOLN NAVIGATOR**

**LOCATION - PENNSYLVANIA**
**CRASH DATE - OCTOBER, 1997**

***BACKGROUND***

This task involved a remote investigation into the single vehicle crash of a 1998 Lincoln Navigator that occurred in the early morning hours of October, 1997. The Lincoln was equipped with a Supplemental Restraint System (SRS) that consisted of depowered driver and passenger side air bags. The Special Crash Investigation (SCI) Team at Calspan SRL was notified of this crash by NASS PSU-05 on Thursday, October 23, 1997. The Calspan Team notified the Field Operations Branch of the National Highway Transportation Safety Administration (NHTSA). NHTSA subsequently assigned this crash as a remote investigation effort on Friday, October 24, 1997

***SUMMARY***

This single vehicle crash occurred in the early morning hours of October, 1997 and involved a 1998 Lincoln Navigator. Immediately prior to the crash, the Lincoln was traveling northbound on a two lane road and turned eastbound onto a three lane road in a protracted right turn.. This maneuver placed the vehicle in the opposing traffic lane. In an attempt to re-enter the proper lane, the driver over-steered to the right and then had to counter-steer back to the left. These steering maneuvers initiated a counterclockwise yaw. The Lincoln yawed approximately 18 m (60 ft) across the westbound traffic lanes and mounted the 18 cm (7 in) barrier curb. The left front tire was aired out as it impacted and mounted the curb. The vehicle then departed the north (left) side of the road, approximately 58 m (190 ft) east of the intersection.

The driver over-steered the vehicle back to the right, while off-road. This maneuver arrested the counterclockwise yaw and initiated a clockwise yaw. The vehicle traveled approximately 27 m (88 ft) through a field and in the process struck several small diameter trees. The Lincoln then entered some brush and encountered a steep embankment bordering the creek. As the Lincoln encountered the embankment, it was off-tracking approximately 10 degrees. The Lincoln fell over the embankment to its left and pitched down. The vehicle struck the opposing creek embankment with its frontal plane and rolled one quarter turn coming to rest on its left side. The vehicle's air bag system deployed as a result of the impact with the embankment.

The 1998 Lincoln Navigator 4x4 MPV was identified by a vehicle identification number (VIN) of 5LMFU28L7WL(production sequence deleted). The vehicle was equipped with a Supplemental

Restraint System that consisted of driver and passenger side air bags. The 4th character in Ford Motor Company's VIN structure indicated the vehicle was equipped with a depowered air bag system.

The Lincoln Navigator was inspected and documented by a researcher from NASS PSU-05. The vehicle had sustained direct contact damage across the full width of the frontal plane with a maximum crush of 35 cm (14 in) recorded at the left front bumper corner (C1). The Collision Deformation Classification (CDC) of the Lincoln for the embankment impact sequence was 12-FDEW-2. A calculation using the barrier model of the SMASH algorithm indicated the barrier equivalent delta V of the Lincoln was approximately 21.8 km/h (13.5 mph). The left side of the vehicle sustained surface abrasions, the left outside mirror was damaged and the window glazing of the left front door and left rear quarterpanel were shattered, all caused by ground contact in the vehicle's quarter turn rollover. Interior inspection revealed the windshield was fractured by occupant contact and there were small areas of blood on the windshield header and headliner.

The driver of the Lincoln was a 36 year old male of unknown height and weight. He was not restrained by the vehicle's manual 3-point lap and shoulder belt system. He had no independent recollection of the crash. During his interview the driver indicated his only injuries in the crash were a laceration to the left side of the forehead near the temple and a contusion to the heel of the right foot. Both injuries were AIS 1. The driver was transported to a local hospital following the crash, where he was treated for his injuries and released. The driver's blood alcohol content (BAC) at the hospital was determined to be 0.21.

**CALSPAN REMOTE DEPOWERED AIR BAG DEPLOYMENT INVESTIGATION**
**CALSPAN CASE NO. CA97-40**
**VEHICLE #1 - 1998 LINCOLN NAVIGATOR**
**LOCATION - STATE OF PENNSYLVANIA**
**CRASH DATE - OCTOBER, 1997**

## CRASH DATA

| | |
|---|---|
| Location: | Off-road |
| State: | Pennsylvania |
| Area/Type: | Rural/Residential |
| Crash Date/Time: | October, 1997/nighttime hours |
| Investigating Police Agency: | Township Police Department |
| Crash Type: | Single vehicle, frontal impact with creek embankment, quarter turn rollover |
| Air Bag Vehicle Occupant Injury Severity: | Driver - Minor (AIS-1) |

## AMBIENCE

| | |
|---|---|
| Viewing Conditions: | Dark, not lighted |
| Weather: | Clear |
| Precipitation: | None |
| Road Surface: | Dry |

## HIGHWAY

| | |
|---|---|
| Type: | Local street |
| Number of Lanes: | 3 |
| Width: | 12.4 m (40.7 ft) |
| Surface: | Asphalt |
| Median: | None |
| North Edge: | 18 cm (7 in) curb |
| Vertical Alignment: | Level |

**HIGHWAY (CONT'D)**

| | |
|---|---|
| Horizontal Alignment: | Straight |
| Estimated. Coefficient of Friction: | 0.7 |
| Traffic Density: | Sparse |

**TRAFFIC CONTROLS**

| | |
|---|---|
| Signals: | None |
| Signs: | None |
| Markings: | Solid double yellow centerline, solid white road edge lines |
| Speed Limit: | 64 km/h (40 mph) |

**AIR BAG VEHICLE**

| | |
|---|---|
| Description: | 1998 Lincoln Navigator 4x4, luxury Sport Utility Vehicle |
| VIN: | 5LMFU28L7WL (production sequence deleted) |
| Color: | White |
| Engine: | 5.4L EFI-SOHC (W) V8 |
| Transmission: | 4-speed automatic |
| Steering: | Power-assisted |
| Brakes: | Power-assisted with ABS(anti-lock) |
| Padding: | Upper and mid instrument panel, sunvisors, soft-edged steering wheel rim, door panels, door armrests, adjustable head restraints and fold-down center armrests |
| Manual Restraints: | 3-point lap and shoulder belt systems in the 6 outboard seated positions with continuous loop belt webbing through a sliding latch plate and adjustable upper anchorages (D-rings) |
| Automatic Restraints: | Depowered driver and passenger side Supplemental Restraint System (SRS) which deployed as a result of the crash |
| Tow Status: | Towed due to vehicle damage |

## VEHICLE DAMAGE

**Exterior:**

The 1998 Lincoln Navigator sustained direct contact damage across the entire 163 cm (64 in) width of the vehicle's frontal plane, primarily as a result of the impact with the creek embankment. The vehicle also sustained minor secondary damage (scratches/dents) as a result of striking several small trees and traveling through the brush bordering the creek. There were abrasions and minor dents to the left side of the Lincoln caused by the ground contact due to the quarter turn roll-over. The residual crush measured at the front bumper fascia attributed to the embankment impact was as follows: C1 =35 cm (14 in), C2=20 cm (8 in), C3=20 cm (8 in), C4=10 cm (4 in), C5=5 cm (2 in), C6=11 cm (4 in). The left front tire was aired out by impact with the curb.

**Figure 1**: Front view

**CDC:**

| Event No. | Object Contacted | Code |
|---|---|---|
| 1 | Trees/brush | 12-FDLU-1 |
| 2 | Embankment | 12-FDEW-2 |
| 3 | Rollover/ground | 00-LDAO-2 |

**Repair Cost:** Estimated $15,000

**Interior:**

Interior damage of the Lincoln Navigator was limited to deployment of the Supplemental Restraint System (SRS) and occupant contacts located primarily forward and above the driver's position. There was no intrusion of the passenger compartment. The left upper aspect of the windshield was fractured due to contact from the driver's head. The windshield fracture was located left of the steering column center line. Hair and blood was identified in the fracture site. The contact caused a laceration to the left aspect of the driver's forehead, near the temple. The head liner was stained with blood in several areas directly above the driver's position, on the center courtesy panel and above the right front seat. The center mirror was displaced to the right probably from right arm contact. Also, the trim panel on the left A pillar was displaced by a source not identified during the NASS inspection.

**Figure 2**: Windshield fracture

**Figure 3**: Headliner - left side

## VEHICLE DAMAGE (CONT"D)

### Interior (Cont'd):

Inspection of the SRS revealed the driver and passenger side air bags had deployed normally from their respective modules. There were no indications that the driver had altered or interfered with the air bag's deployment path. The face of the driver air bag was spattered with blood in the upper left quadrant. These spatters were attributed to post crash contact due to blood from the head laceration.

**Figure 4**: Driver air bag

## AUTOMATIC RESTRAINT SYSTEM

The 1998 Lincoln Navigator was equipped with a Supplemental Restraint System (SRS) that consisted of dual driver and passenger side air bags which deployed as a result of the impact sequence with the creek embankment. The driver air bag was incorporated into the steering wheel hub assembly in a typical configuration while the passenger side air bag was mounted in a pure mid-mount configuration of the right side of the instrument panel.

The driver's side air bag deployed as designed from an H-configuration air bag module cover assembly that was contained within the steering wheel rim. The H-configuration module cover flaps were hinged at the top and bottom with a horizontal center tear seam. The flaps were symmetrical and measured 12.0 cm (4.7 in) by 19.0 cm (7.5 in), width by height respectively. The bag was tethered with two internal straps and was vented by two ports located in the 11 and 1 o'clock sectors on the back side of the bag. The face of the air bag was spattered with blood in the upper left quadrant. The steering column was a tilt column and was found adjusted to the center position.

The passenger side air bag deployed as designed from its mid-mount configuration located on the right side of the instrument panel. The single flap module cover was hinged on the forward edge of the module (with respect to the vehicle). The cover flap measured 38.5 cm (15.2 in) by 18.0 cm (7.1 in), width by height. The passenger air bag was not vented and rectangular in shape, with a rearward excursion of approximately 61 cm (24 in)

## MANUAL RESTRAINTS

The 1998 Lincoln Navigator was equipped with manual 3-point lap and shoulder belts in the six outboard seated positions. The seat belt systems consisted of a continuous loop lap and shoulder belt webbing with a sliding latch plate. The belt systems utilized an adjustable upper anchorage (D-ring). The driver's side D-ring was found adjusted in the full down position. There were no routine usage marks present on the left front latchplate. There was no loading evidence on the driver side seat belt webbing or any indication that the restraint was used in the crash. The driver also indicated that he was unrestrained.

## COLLISION SEQUENCE

**Pre-Crash:**

Prior to the crash, the driver of the Lincoln Navigator was at a local country club. He reported that he was with a friend who was going to drive him home. However, prior to departing the facility, he found that his friend had already left without him. The individual then elected to drive himself home.

The driver left the country club and immediately prior to the crash was traveling northbound on a two lane road approaching an intersection. The driver turned eastbound in a protracted right turn and found himself in the westbound traffic lane. Scene investigation by the police and Nass researcher located a short yaw mark attributed to the left side tires of the Lincoln. The driver initiated right steer to enter the proper lane and in the process over-steered. The driver then counter-steered back to the left which initiated a counterclockwise yaw. The Lincoln yawed approximately 18 m (60 ft) across the westbound traffic lanes, mounted the 18 cm (7 in) barrier curb and traveled off the north side of the road. The vehicle traveled approximately 27 m (88 ft) through a field and down a steep embankment into a creek. In the process of the off-road travel, the driver of the Lincoln had steered back to the right. The tire tracks through the field indicated the vehicle was not tracking and had begun to yaw in a clockwise direction.

**Crash:**

Immediately prior to entering the creek, the vehicle struck several small diameter trees and brush bordering the creek. The creek was approximately 66 cm (26 in) deep and the embankments bordering the creek were steeply sloped (approximately 80 degrees). As the vehicle encountered the embankment, it had yawed approximately 10 degrees clockwise. The Lincoln pitched down the creek embankment, leading with the left front of the vehicle. Due to the steep embankment slope, the vehicle probably began to fall over at this point. The Lincoln struck the opposing creek embankment with the vehicle's frontal plane. The vehicle's air bag system deployed as a result of the 12 o'clock direction of the impact forces. The impact generated a vehicular delta V of approximately 21.8 km/h (13.5 mph). The Lincoln then completed the fall-over rolling one quarter turn coming to rest on its left side in the creek.

**Post-Crash:**

The Lincoln came to rest on its left side in the dry creek bed, approximately 17 m (55 ft) north of the road. Debris and glass was located in the creek bed near the point of impact. A witness to the crash in a gas station at the intersection reported event.

The Lincoln sustained disabling damage and had to be towed from the scene. The driver was transported to a local medical facility where he was treated for minor injuries and released. At the hospital it was determined that his BAC was 0.21. The driver had no independent recollection of the crash during his interview.

## HUMAN DEMOGRAPHICS/OCCUPANT DATA

### Air Bag Vehicle

| | |
|---|---|
| Driver: | 36 year old male |
| Height: | Not reported |
| Weight: | Not reported |
| Manual Restraint Usage: | None |
| Usage Source: | Vehicle inspection, interview |
| Eyewear: | Prescription glasses |
| Mode of Transport From Scene: | Ambulance |
| Type of Medical Treatment: | Transported to local hospital where he was treated for minor injuries and released |
| Vehicle Familiarity: | Familiar, 3,318 km (2,062 miles) at inspection |
| Route Familiarity: | Familiar, resident of area |

## DRIVER INJURIES

| Injury | Severity (AIS-90) | Injury Mechanism |
|---|---|---|
| Forehead laceration (NFS) | 190600.1,7 | Windshield contact |
| Heel contusion | 890402.1,1 | brake pedal |

## DRIVER KINEMATICS

The driver was unrestrained by the manual 3-point lap and shoulder belt system seated in the vehicle with the seat adjusted in a mid-track position. In the course of the crash sequence, the driver was "wrestling" for control of the vehicle and his actions of over-steering precipitated the off-road travel. These actions in addition to his physical state probably placed him in a forward position relative to the normally seated occupant. As the vehicle departed the roadway, it was yawing counterclockwise. Over the course of the off-road travel the driver steered back to the right and upon its encounter with the brush and small trees bordering the creek, it was rotating clockwise. The vehicle impacted several small trees at the brush line. The driver responded to these minor frontal impacts by moving forward and left due to the vehicle rotation. At the creek embankment, the vehicle pitched down and began to fall-over to the left. The vehicle's trajectory into the creek caused the driver to move upward and further forward and left with respect to the vehicle. At the time of the impact with the opposing embankment, the driver was in close proximity to the windshield.

**DRIVER KINEMATICS (CONT"D)**

The impact with the embankment caused the driver to strike the left side of his head on the windshield, depositing hair and blood in the contact point. This contact caused an AIS-1 laceration. The air bags deployed normally from their respective modules. The forward and leftward trajectory of the driver placed the driver left of the steering wheel centerline. It is probable that the driver air bag deployed past the right aspect of the driver's chest. There were no indications that the driver had any interactions with the air bag during its deployment sequence.