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REDESIGNED AIR BAG REPORT

CASE NUMBER - IN97-036
LOCATION - TEXAS
VEHICLE - 1998 LINCOLN NAVIGATOR
CRASH DATE - October, 1997

Submitted:

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Contract Number: DTNH22-94-D-17058

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

Technical Report Documentation Page

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15. *Supplementary Notes*
On-site air bag deployment investigation involving a 1998 Lincoln Navigator, four-door MPV, with manual safety belts and dual front redesigned air bags, and a 1998 Ford truck-tractor with 2 semi-trailers

16. *Abstract*

This report covers an on-site investigation of an air bag deployment crash that involved a 1998 Lincoln Navigator (case vehicle) and a 1998 Ford Aeromax truck-tractor (other vehicle) pulling two semi-trailers. This crash is of special interest because the Lincoln was equipped with redesigned air bags, and the Lincoln's driver [40-year-old, Black (unknown if Hispanic) male] sustained only a minor injury from his deploying driver air bag. The Lincoln was traveling north in the center northbound lane of a three-lane, one-way, city roadway. The Ford had been stopped traveling east in the center lane of a three-lane, one-way, divided, service road for an Interstate trafficway and began to accelerate forward. Based upon the available evidence, the Lincoln's driver made no apparent avoidance maneuvers prior to the crash. According to his interview, the Ford's driver recognized the impending collision and stopped his rig just prior to impact, attempting to avoid the crash. The crash occurred in the center of the four-leg intersection of the two roadways. The front left corner of the Lincoln impacted the right front of the Ford in an end swiping manner, causing the Lincoln's driver and front right passenger supplemental restraints (air bags) to deploy. The Ford came to rest, heading east, essentially at the point of impact. The Lincoln rotated approximately 225 degrees counterclockwise and came to rest in the intersection, heading southeastward. The Lincoln's driver was seated but the exact position of his seat track is unknown; however based on the vehicle inspection, the seat track was located at least between its middle and forward-most positions, and the exact position of the tilt steering wheel is unknown. The Lincoln's driver may have been restrained by his available, active, three-point, lap-and-shoulder, safety belt system and sustained, according to his medical records, minor injuries which included: an avulsion and contusion to his left elbow; abrasions to his left distal forearm, right thumb, and left shin; lacerations to his right hand; and contusions to his face, left thigh, and bilateral knees. The driver's air bag most likely caused his facial contusion and the abrasion to his right thumb.

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BACKGROUND

IN97-036

This on-site report was brought to NHTSA's attention on October 24, 1997, by NASS sampling activities. This crash involved a 1998 Lincoln Navigator (case vehicle) and a 1998 Ford Aeromax truck-tractor (other vehicle) pulling a semi-trailer and a full trailer. The crash occurred in October, 1997, at 2.30 a.m., in Texas and was investigated by the applicable city police department. This crash is of special interest because the Lincoln was equipped with redesigned air bags, and the Lincoln's driver [40-year-old, Black (unknown if Hispanic) male] sustained only a minor injury from his deploying driver air bag. This contractor's investigative consultant inspected the scene and vehicles during the spring of 1998. This contractor interviewed the driver for the Ford truck-tractor on May 14, 1998. This report is based on the Police Crash Report, an interview with the Ford's driver, the Lincoln's vehicle inspection (Note: a scene inspection was not allowed), occupant kinematic principles, occupant medical records, and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The Lincoln was traveling north in the center northbound lane of a three-lane, one-way, city roadway and intended to continued traveling northward [it is unclear what the type of lanes were (most likely two through lanes and one right-hand turn lane) and the trafficway was most likely divided]. The Ford had been stopped traveling east in the center lane of a three-lane, one-way, divided, service road for an Interstate trafficway and began to accelerate forward, intending to continue through the signalized intersection [it is once again unclear what the type of lanes were (most likely there were two through lanes and a left-hand turn lane)]. Based upon the available evidence, the Lincoln's driver made no apparent avoidance maneuvers prior to the crash. According to his interview, the Ford's driver recognized the impending collision and stopped his rig just prior to impact, attempting to avoid the crash. The crash occurred in the center of the four-leg intersection of the two roadways.

Based on the Police Crash Report, the city roadway on which the Lincoln was traveling was straight, but it is unknown if the roadway was level or at a grade because this contractor's investigative consultant was not allowed to inspect the crash site. The interstate service roadway from which the Ford truck-tractor entered the intersection was straight, but once again, its vertical alignment is unknown (i.e., level versus grade). The pavement was concrete, but the width of the travel lanes for both vehicles are unknown. Both roadways were most likely bordered by curbs. According to the Police Crash Report, the pavement markings or both roadways consisted of single broken lane lines used to separate each of the three travel lanes. The four-leg intersection was controlled by on-colors, pre-timed, traffic control signals. The speed limit for both of the roadways was 64 km.p.h. (40 m.p.h.). At the time of the crash the light condition was dark, but illuminated by overhead street lamps at the area of impact, the atmospheric condition was cloudy, and the road pavement was dry. Traffic density was unknown, and the site of the crash was urban and most likely commercial and/or industrial.

The front left corner (**Figures 1** and **2** below) of the Lincoln impacted the right front of the Ford in an end swiping manner, causing the Lincoln's driver and front right passenger supplemental restraints

(air bags) to deploy. The Ford came to rest, heading east, essentially at the point of impact. According to the Police Crash Report, the Lincoln rotated approximately 225 degrees counterclockwise and came to rest in the intersection, heading southeastward.

Figure 1: Lincoln's very narrow front left impact viewed from front; Note: Lincoln's front left bumper underrode right front bumper corner of Ford truck-tractor (case photo #01)

Figure 2: Lincoln's very narrow front left damage viewed from left front; Note: direct damage extends to just short of left "A"-pillar, left "A"-pillar is pushed backwards, and left front tire is deflated and restricted (case photo #02)

CASE VEHICLE

The 1998 Lincoln Navigator was a rear wheel drive, seven-passenger, four-door multiple purpose vehicle (VIN: 5LMRU27L7WL------) equipped with a 5.4L, V-8 engine and a four-speed automatic transmission. Braking was achieved by a power-assisted, four-wheel, anti-lock system. The Lincoln's wheelbase was 303 centimeters (119.1 inches), and the odometer reading at inspection was 5,662 kilometers (3,518 miles).

Inspection of the vehicle's interior revealed: adjustable front bucket seats with adjustable head restraints; adjustable bucket seats with adjustable head restraints in the second seating area; a non-adjustable back bench seat with integral head restraints for the back outboard seating positions; continuous loop, three-point, lap-and-shoulder, safety belt systems at the front, second seating area, and back outboard positions; and a two-point, lap belt system at the back center position. The front seat belt systems were equipped with manually operated height adjusters for the "D"-rings. The vehicle was equipped with knee bolsters for both the driver and front right passenger, neither of which were deformed. Automatic restraint was provided by a Supplemental Restraint System (SRS) that consisted of a redesigned frontal air bags for the driver and front right passenger seating positions. Both front seat air bags deployed as a result of the Lincoln's impact with the Ford truck-tractor.

The Lincoln's contact with the Ford truck-tractor involved the left one-third of the Lincoln's front (**Figure 1**) with the direct damage primarily at the front left corner. Direct damage began at the front left

bumper corner and extended, a measured distance of 49 centimeters (19.3 inches), inward from the front left bumper corner with indirect damage extending across the entire front bumper. Maximum crush (adjusted for free space) was measured as 40 centimeters (15.7 inches) at C_1 (**Figure 2**). The wheelbase on the Lincoln's left side was shortened 15 centimeters (5.9 inches) while the right side was not shortened. The Lincoln's front bumper, bumper fascia, grille, hood, front left turn headlight and turn signal assemblies, and left fender were directly damaged and crushed rearward. The Lincoln's left front tire was deflated and physically restricted (**Figure 2** above). The front right headlight and turn signal assemblies, hood, windshield, and left outside rearview mirror sustained induced damage; the left "A"-pillar was buckled rearward. Remote buckling was also found on the left portion of the Lincoln's roof over the driver's door (**Figures 3** and **4**). The driver's seating area sustained intrusion from the left "A"-pillar, windshield header, left instrument panel (**Figure 5**), and toe pan components. The center instrument panel intruded into the front center area of the Lincoln (**Figure 6** below).

The inspection of the Lincoln's interior revealed contact evidence on the driver's air bag, a scuff below the center instrument panel, and a broken vent in the center instrument panel. Based on the vehicle inspection, the CDC for the Lincoln was determined to be: **12-FLEE-5 (350)**. No reconstruction program was used on this crash because the NASS, CDS, WinSMASH protocol requires that both vehicles be within scope of the reconstruction program (i.e., CDS-applicable) and that no swiping was involved; however, this contractor's visually estimated Delta V to the Lincoln was low [i.e., between 14 km.p.h. (9 m.p.h.) and 23 km.p.h. (14 m.p.h.)]. The Lincoln was towed due to damage.

The Lincoln's driver air bag was located in the

Figure 3: Close-up of Lincoln's driver door area showing narrow frontal impact's penetration along left side, rearward displacement of left "A"-pillar, left roof buckling, and jammed driver's door (case photo #03)

Figure 4: Lincoln's very narrow front left impact viewed from left back (case photo #04)

Figure 5: Lincoln's front seating area from right showing deployed front air bags and longitudinal intrusion to driver's seating area from left "A"-pillar and left and center instrument panels (case photo #05)

steering wheel hub. The module cover consisted of asymmetrical "H"-configuration cover flaps made of thick vinyl with overall dimensions of 19 centimeters (7.5 inches) at the horizontal seam and 20 centimeters (7.9 inches) vertically for the upper flap and 8 centimeters (3.1 inches) vertically for the lower flap. An inspection of the air bag module's cover flaps and air bag fabric revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps (**Figure 6** and see **SELECTED PHOTOGRAPHS**, specifically **Figure 9** below). The driver's air bag was designed with tethers, but the exact number is unknown. The driver's air bag had two vent ports, of unknown diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with diameter 64 centimeters (25.2 inches). Inspection of the driver's air bag revealed blood evidence at the top of the air bag's front surface at the 12 o'clock position and toward the 2 and 5 o'clock positions, but relatively close to the center of the air bag (**Figure 7**). In addition, there were some scuffs present on the right upper and lower quadrants. The scuffs in the upper right quadrant were toward the 1 o'clock position but relatively close to the center of the air bag. On the other hand, the scuffs in the lower right hand quadrant were near the bottom of the air bag's front surface toward the 5:30 o'clock position.

Figure 6: Lincoln's front seating area from left showing longitudinal intrusion to driver's seating area from left and center instrument panels and likely position of driver's seat (case photo #06)

Figure 7: Lincoln's deployed driver air bag showing blood evidence, primarily at 12 o'clock position (case photo #08)

Figure 8: Lincoln's deployed front right passenger air bag showing no occupant contact evidence (case photo #12)

The front right passenger's air bag was located in the middle of the instrument panel. There was a single, essentially rectangular, modular cover flap (see **SELECTED PHOTOGRAPHS**, specifically **Figure**

10 below). The cover flap was made of a thick vinyl over a thick cardboard type frame. The flap's dimensions were 39 centimeters (15.4 inches) at the lower horizontal seam and 17 centimeters (6.7 inches) along both vertical seams. An inspection of the front right air bag module's cover flap and air bag fabric revealed that the cover flap opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed without any tethers. The front right air bag had no vent ports. The deployed front right air bag was rectangular with a height of approximately 55 centimeters (21.7 inches) and a width of approximately 50 centimeters (19.7 inches). An inspection of the front right air bag revealed that there was no contact evidence readily apparent on the air bag (**Figure 8** above).

CASE VEHICLE OCCUPANT

Immediately prior to the crash the exact posture of the Lincoln's driver is unknown; however, he was most likely seated in a reclined posture with his back against the seat back, his left foot on the floor, his right foot on the accelerator, his left elbow on or near the driver's window sill, and both hands on the steering wheel. The exact position of his seat track is unknown, but based on the vehicle inspection by this contractor's investigative consultant, the seat track was located at least between its middle and forward-most positions (**Figure 6** above), the seat back was sightly reclined, and the exact position of the Lincoln's tilt steering wheel is unknown.

According to the Police Crash Report, the Lincoln's driver (of unknown height and weight) was restrained by his available, active, three-point, lap-and-shoulder, safety belt system. However, there was no evidence of belt pattern bruising and/or abrasions to the driver's passenger's body. In addition, the inspection of the driver's seat belt webbing, "D"-ring, and latch plate showed no evidence of loading. Post-crash the Lincoln's driver had a blood alcohol level of .149 mg/dl.

Based upon the available evidence, the Lincoln's driver made no known pre-crash avoidance maneuvers. As a result and independent of the use or nonuse of his available safety belts, his pre-impact body position did not change just prior to impact. The Lincoln's impact with the Ford enabled the Lincoln's driver to continue forward and slightly upward toward the 350 degree Direction of Principal Force as the Lincoln decelerated. As the Lincoln's driver moved forward he contacted the deploying driver's air bag with his chest and face. In addition, his left knee and lower leg loaded into the left instrument panel and his right knee contacted the center instrument panel. As a result of very narrow end engagement the Lincoln rotated counterclockwise enabling the front left one-third of the Lincoln's front to directly contact the front portion of the Ford as the Lincoln rotated around counterclockwise prior to the disengagement of the two vehicles. As a result the Lincoln's driver, who was most likely in contact with the deployed driver air bag and steering wheel, most likely moved toward his right as the Lincoln began to rotate rapidly counterclockwise. As the Lincoln separated from the Ford's front and continued its counterclockwise rotation, the Lincoln's driver most likely move first backwards towards the center console and subsequently leftward towards the driver's door, driver's seat back, and left "B"-pillar as the Lincoln continued to spin counterclockwise. The exact posture of the Lincoln's driver at final rest is

unknown, but he was most likely against the driver's seat back as the vehicle came to rest.

DRIVER INJURIES

The driver was transported by ambulance to the hospital. He sustained minor injuries and was most likely treated and released, at least 3 hours post-crash. The injuries sustained by the Lincoln's driver included: an avulsion and contusion to his left elbow; abrasions to his left distal forearm, right thumb, and left shin; lacerations to his right hand; and contusions to his face, left thigh, and bilateral knees. The driver's air bag most likely caused his facial contusion and the abrasion to his right thumb. The left elbow lesions resulted from contact with the driver's door sill and/or glazing.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Contusion face, location not further specified	290402.1 minor	Air bag, driver's	Probable	Emergency room records
2	Avulsion {flap-type laceration}, 1.5 cm (0.6 in), left elbow involving subcutaneous tissue	790802.1 minor	Window sill and/or glazing, left {driver's} door	Probable	Emergency room records
3	Contusion left elbow	790402.1 minor	Window sill, left {driver's} door	Probable	Emergency room records
4	Abrasion left distal forearm	790202.1 minor	Noncontact injury: flying glass–left {driver's} glazing	Possible	Emergency room records
5	Abrasion right thumb	790202.1 minor	Air bag, driver's	Probable	Emergency room records
6	Lacerations, several, right hand	790600.1 minor	Noncontact injury: flying glass–left {driver's} glazing	Possible	Emergency room records
7	Contusion left thigh, location not further specified	890402.1 minor	Steering wheel rim	Probable	Emergency room records
8	Contusion left knee	890402.1 minor	Left instrument panel and below	Probable	Emergency room records
9	Contusion right knee	890402.1 minor	Center instrument panel and below	Probable	Emergency room records
10	Abrasions shin, left lower leg	890202.1 minor	Left instrument panel and below	Probable	Emergency room records

OTHER VEHICLE

The 1998 Ford Aeromax was a rear wheel drive, 4 x 2, two-door, three-passenger, truck-tractor, pulling two semi-trailers (VIN: 1FTYY92P7WV------). One of the semi-trailers is not discernable (i.e., VIN is undefined), but the other semi-trailer was manufactured by Great Dane (VIN: 1GRAA56120B------). The Ford truck-tractor was equipped with a 10.8L, IL-6, Cummings M-11 turbo diesel engine and a ten-speed manual transmission. The Ford's wheelbase was 376 centimeters (148.0 inches), and because the Ford was not inspected, the odometer reading is unknown.

With no available vehicle photographs but based on the closing trajectories, the TDC was estimated as: **03-RFEE-3 (090)** for the Ford truck-tractor. The Ford was towed due to damage.

Figure 9: Vertical view of Lincoln's driver seating area showing crash induced damage to windshield's glazing, intrusion from left "A"-pillar and instrument panel, and driver air bag module's top cover flap which was without evidence of contact (case photo #17)

Figure 10: Vertical view of Lincoln's front right passenger seating area showing front right passenger air bag module's cover flap and folded, deployed air bag (case photo #19)