

CRASH DATA RESEARCH CENTER

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**VERIDIAN REMOTE SIDE IMPACT OCCUPANT PROTECTION
INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

NASS/SCI COMBO CASE NO. 2000-09-071C

VEHICLE - 2000 LINCOLN TOWN CAR EXECUTIVE

LOCATION - STATE OF MARYLAND

CRASH DATE - MAY, 2000

Contract No. DTNH22-94-D-07058

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.

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<p>16. <i>Abstract</i> This remote investigation focused on a single vehicle crash involving a 2000 Lincoln Town Car Executive 4-door sedan, equipped with a side impact occupant protection system. The left side impact air bag deployed as a result of a left side collision with a fire hydrant. The driver of the Lincoln Town Car was operating the vehicle westbound and negotiating a left curve when he allowed the vehicle to depart the right (north) pavement edge in a clockwise yaw. As the vehicle exited the north pavement edge, the left passenger area made initial contact to a fire hydrant resulting in moderate damage. The left passenger area subsequently impacted a mailbox post which resulted in minor damage. The Lincoln continued in a northwesterly direction as the left passenger area struck a large diameter tree resulting in severe damage. At impact with the fire hydrant, the unrestrained 17 year old male driver of the 2000 Lincoln Town Car initiated a lateral trajectory in response to the 9 o'clock impact force and loaded the deployed side impact air bag. At impact with the tree, the left side impact air bag deflated as he repeated a lateral trajectory in response to the 9 o'clock impact force and loaded the left front door interior surface and B-pillar. Loading of the B-pillar resulted in multiple soft tissue injuries to the left face and scalp, a left chest contusion (with an underlying left lung contusion) and multiple fractures of the left ribs. He also sustained additional soft tissue injury to the right face/head (with an underlying closed head injury) and multiple fractures of the right pelvis from passenger loading into the driver space. The driver was transported to a local trauma center for treatment and admitted for 7 days. At impact with the tree, the unrestrained front right passenger initiated a lateral trajectory in response to the 9 o'clock impact force and loaded the center arm rest with subsequent contact to the driver. Contact to the driver resulted in a nose fracture and contusion of the left upper back. He also sustained multiple (small) lacerations to the posterior aspect of the left arm from flying glass. The passenger was transported to the emergency room of a local hospital for treatment and released.</p>			
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CRASH DATE - MAY, 2000**

BACKGROUND

This remote investigation focused on a single vehicle crash involving a 2000 Lincoln Town Car Executive 4-door sedan equipped with a side impact occupant protection system. The left side impact air bag deployed as a result of a left side collision with a fire hydrant. The driver of the Lincoln Town Car was operating the vehicle westbound and negotiating a left curve when he allowed the vehicle to depart the right (north) pavement edge in a clockwise yaw. As the vehicle exited the north pavement edge, the left passenger area made initial contact to a fire hydrant resulting in moderate damage. The left passenger area subsequently impacted a mailbox post which resulted in minor damage. The Lincoln continued in a northwesterly direction as the left passenger area struck a large diameter tree resulting in severe damage. At impact with the fire hydrant, the unrestrained 17 year old male driver of the 2000 Lincoln Town Car initiated a lateral trajectory in response to the 9 o'clock impact force and loaded the deployed side impact air bag. At impact with the tree, the left side impact air bag deflated as he repeated a lateral trajectory in response to the 9 o'clock impact force and loaded the left front door interior surface and B-pillar. Loading of the B-pillar resulted in multiple soft tissue injuries to the left face and scalp, a left chest contusion (with an underlying left lung contusion) and multiple fractures of the left ribs. He also sustained additional soft tissue injury to the right face/head (with an underlying closed head injury) and multiple fractures of the right pelvis from passenger loading into the driver space. The driver was transported to a local trauma center for treatment and admitted for 7 days. At impact with the tree, the unrestrained front right passenger initiated a lateral trajectory in response to the 9 o'clock impact force and loaded the center arm rest with subsequent contact to the driver. Contact to the driver resulted in a nose fracture and contusion of the left upper back. He also sustained multiple (small) lacerations to the posterior aspect of the left arm from flying glass. The passenger was transported to the emergency room of a local hospital for treatment and released.

This crash was initially selected for investigation by the National Automotive Sampling System (NASS) as CDS case number 00-09-071C. The Crash Investigation Division of the National Highway Traffic Safety Administration (NHTSA) assigned the Special Crash Investigation (SCI) team at Veridian/Calspan the task of case review and report preparation.

SUMMARY

Crash Site

This single vehicle crash occurred during the early morning hours of May, 2000. At the time of the crash, it was dark (street lighted) with rainy conditions as the roads were wet. The crash occurred off the north pavement edge of a level 4-lane undivided roadway which curved left for westbound traffic (**Figure 8 - page 7**). The asphalt roadway was bordered by barrier curbs, residential driveways and mailboxes. Additional roadside objects consisted of a fire hydrant located 0.7 meters (2.3 feet) off the north curblines and a large diameter tree located 7.0 meters (23.0 feet) off the north curblines. No traffic control was present at the scene which had a posted speed limit of 48 km/h (30 mph).

Pre-Crash

The 17 year old male driver of the 2000 Lincoln Town Car Executive was operating the vehicle westbound in the outboard lane of the 4-lane roadway and negotiating a left curve on wet pavement. As the Lincoln reached the apex of the curve, the vehicle broke traction on the wet road surface and began a counterclockwise yaw subsequently entering the eastbound lanes. Upon recognition of the impending harmful event, the driver over steered a right avoidance maneuver which re-directed the vehicle towards the north curb in a clockwise yaw (**Figure 1**).

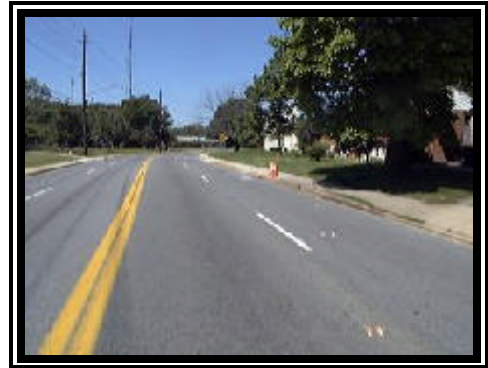


Figure 1. Westbound approach for the 2000 Lincoln Town Car Executive.

Crash

As the Lincoln departed the north pavement edge in a clockwise yaw, the vehicle traveled 0.7 meters (2.3 feet) as the left passenger area made initial contact with a fire hydrant (**Figure 2**) resulting in moderate damage. The impact induced deceleration was sufficient to deploy the left side impact air bag. *Contrary to the NASS case file*, a barrier equivalent velocity change for this impact could not be computed due to the overlapping nature of subsequent impacts. The left passenger area subsequently struck a mailbox post which resulted in minor damage. At this point, the vehicle continued in a northwesterly direction 16.7 meters (54.8 feet) as the left passenger area impacted a large diameter tree (**Figure 3**) resulting in severe damage. The Lincoln rotated counterclockwise 60 degrees and came to rest against the final impact facing northwest.



Figure 2. Struck fire hydrant (foreground) and mailbox post (background).



Figure 3. Southeast look back view from the tree impact and final rest (tree uprooted/removed).

Post-Crash

The driver of the Lincoln was reportedly entrapped by intruded components and removed by rescue personnel in an unconscious state while the front right passenger exited under his own power. Treatment was rendered at the scene by emergency medical technicians (EMTs) and fire department personnel. Both occupants were transported by ambulance to a local hospital for treatment as the driver was subsequently admitted for seven days and the passenger was treated and released. The vehicle was towed from the scene with disabling damage.

VEHICLE DATA

The 2000 Lincoln Town Car Executive was identified by the Vehicle Identification Number (VIN): 1LNHM81WXY (production sequence deleted). The rental vehicle was a 4-door sedan equipped with rear wheel drive, anti-lock braking system and a 4.6 liter, V-8 engine. The vehicle's odometer reading was unknown at the time of the crash. The seating was configured with a front split and rear bench seat. Previous crashes or maintenance on the air bag system were unknown as the vehicle's history was somewhat limited. No cell phone was present or in-use at the time of the collision.

VEHICLE DAMAGE

Exterior Damage

The 2000 Lincoln Town Car sustained moderate left side damage as a result of the impact with the fire hydrant (**Figures 4 & 5**). A narrow damage pattern was identified just rearward of the left A-pillar as the direct damage began 181.0 cm (71.3 in) forward of the left rear axle and extended forward 51.0 cm (20.1 in). The Collision Deformation Classification (CDC) for this initial impact to the Lincoln was 09-LPEW-9 (unknown crush extent zone represented by a "9"). Direct contact damage was also identified to the left B-pillar area attributed to the tree impact. The direct contact damage began 130.0 cm (51.2 in) forward of the left rear axle and extended forward 54.0 cm (21.3 in). The combined direct and induced damage length (Field L) for all impacts began at the left rear axle and extended forward 239.0 cm (94.1 in). Six crush measurements were documented at the level of the lower door: C1= 5.0 cm (2.0 in), C2= 17.0 cm (6.7 in), C3= 70.0 cm (27.6 in), C4= 61.0 cm (24.0 in), C5= 53.0 cm (20.9 in), C6= 20.0 cm (7.9 in). A maximum crush value of 79.0 cm (31.1 in) was documented between the C3 and C4 positions. *Contrary to the NASS case file*, the CDC for this (overlapping/highest Delta-V) final impact to the Lincoln was 09-LPAW-4 (*no vehicle bowing*). The left front wheel was restricted (not deflated) as the left rear wheel/tire was deflated (not restricted). The left side doors were jammed as the left side tempered glazings were disintegrated by the impact force. Lateral displacement of the A-pillar and B-pillar fractured the windshield and produced extensive buckling of the roof and header areas. Minor hood displacement was noted. Reduction in the left side wheelbase measured 15.0 cm (5.9 in) as the right side wheelbase was elongated 3.0 cm (1.2 in). Pry marks were noted to the left front door (with the right front door removed) from rescue personnel during occupant extrication activities post-crash, and further invalidated the crush profile for Delta-V calculations.



Figure 4. Oblique view of the 2000 Lincoln Town Car Executive.



Figure 5. Overlapping damage to the left side surface.

Interior Damage

Interior damage to the Lincoln identified through the NASS vehicle inspection was severe and attributed to occupant contact and component intrusions (**Figure 6**). Scuff marks and indentations were documented on the left front door interior surface and B-pillar. Scuff marks were also noted to the upper left front door panel from the side impact air bag deployment. The center armrest was displaced to the left with loading marks noted on the right aspect of the driver seat back. The front left and center seats were deformed to a rearward mid-range position by extensive lateral intrusions. Lateral intrusions into the driver space involved 50.0 cm (19.7 in) of door panel/B-pillar, 14.0 cm (5.5 in) of sill, 25.0 cm (9.8 in) of kick panel, 26.0 cm (10.2 in) of roof side rail, 17.0 cm (6.7 in) of center armrest, and 4.0 cm (1.6 in) of A-pillar intrusion. Lateral intrusions into the rear left occupant space involved 51.0 cm (20.1 in) of door panel, 32.0 cm (12.6 in) of sill, and 6.0 cm (2.4 in) of roof side rail intrusion.

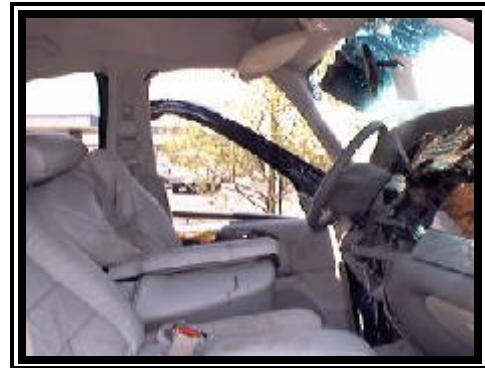


Figure 6. Interior view.

SUPPLEMENTAL RESTRAINT SYSTEMS

The 2000 Lincoln Town Car Executive was equipped with redesigned frontal air bags for the driver and front right passenger positions. The frontal air bags did not deploy as a result of the crash. The driver air bag was housed in the center of the steering wheel with a vertically oriented flap tear seam (I-configuration). The front right passenger air bag was housed in the right mid-instrument panel with a single cover flap design hinged at the top aspect.

The Lincoln was also equipped with seat-mounted side impact air bags for the front outboard seating positions. The left side impact air bag deployed as a result of the crash. The air bags were housed in the outboard aspect of the front seat backs with a vertically oriented tear seam integrated into the seat back stitching. The air bag membrane inflated vertically to offer head and thoracic protection. The module was rectangular in shape and measured 9.0 cm (3.5 in) in width and 22.0 cm (8.7 in) in height. The NASS researcher measured the left side impact air bag at 35.0 cm (13.8 in) in width and 62.0 cm (24.4 in) in height in its deflated state (**Figure 7**). The bag was vented by one port located on the forward (centered) aspect of the air bag. No contact evidence was identified on the air bag membrane, however, bag interaction by the driver produced the noted scuff marks to the upper left door panel. No internal tether straps were present.



Figure 7. 2000 Lincoln Town Car Executive deployed side impact air bag.

DRIVER DEMOGRAPHICS

Age/Sex: 17 year old male
Height: 173 cm (68 in)
Weight: 68 kg (150 lb)
Seat Track Position: Middle position
Manual Restraint Use: None
Usage Source: NASS vehicle inspection, surrogate interview, police report
Eyeware: None
Type of Medical Treatment: Transported to a local trauma center and admitted (7 days)

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Contusion left lung (lower lobe)	Serious (441406.3,2)	Left B-pillar
*Fracture right pelvis (displaced) (inferior and superior pubic ramus)	Serious (852604.3,5)	Passenger (armrest loading)
*Closed head injury	Moderate (160406.2,0)	Passenger
*Fracture posterior left 11 th & 12 th ribs	Moderate (450220.2,2)	Left B-pillar
*Fracture dorsal right pelvis (sacral)	Moderate (852600.2,6)	Passenger (armrest loading)
+Contusion right scalp	Minor (190402.1,1)	Passenger
+Laceration anterior scalp (minor)	Minor (190602.1,5)	Passenger
#Laceration left scalp - minor (above temple - 6cm)	Minor (190602.1,2)	Left B-pillar
+Laceration right eyelid	Minor (297602.1,1)	Passenger
*Contusion left face	Minor (290402.1,2)	Left B-pillar
+Contusion left chest	Minor (490402.1,2)	Left B-pillar
+Abrasion right elbow	Minor (790202.1,1)	Passenger
+Abrasion right knee	Minor (890202.1,1)	Passenger

sources - discharge summary / ER report+ / interviewee#*

Driver Kinematics

The unrestrained 17 year old male driver of the 2000 Lincoln Town Car was presumed to be seated in an upright posture with the seat back slightly reclined and the seat track adjusted to the middle position. The NASS surrogate interview stated he was unrestrained, further evidenced by the extensive lateral intrusions and resulting belt restriction (in the stowed position) seen in the interior vehicle images.

At impact with the fire hydrant, he initiated a lateral trajectory in response to the 9 o'clock impact force

and loaded the deployed side impact air bag and left front door interior surface. Interaction with the deployed air bag was confirmed by the scuff marks documented to the upper left front door panel. At impact with the tree, the deployed side impact air bag had deflated as the vehicle traveled 16.7 meters (54.8 feet) between impacts. The driver was out-of-position to the left and repeated a lateral trajectory in response to the 9 o'clock impact force. He loaded the left front interior door surface and B-pillar, resulting in multiple soft tissue injuries which involved a left scalp laceration, contusion to the left face and lateral chest. In addition, the 11th and 12th posterior left ribs were fractured along with an underlying lung contusion. These injury mechanisms were evidenced by the kinematic response pattern relative to the scuff marks documented on the left B-pillar. Contact to the door panel and armrest was confirmed by the deformation documented to this component, however, no resulting lower extremity injury was reported. At this point, the *passenger* loaded the center armrest which further compressed the driver against the B-pillar resulting in multiple fractures of the right pelvis. This injury mechanism was evidenced by the aspect of the pelvic injury in conjunction with the extensive lateral displacement of the center armrest. The passenger's upper torso and head continued the lateral kinematic response into the front left space with subsequent contact to the driver. This occupant-to-occupant impact resulted in an unspecified closed head injury and additional soft tissue injury to the driver which involved lacerations to the right eyelid and scalp, a contusion to the right scalp and elbow, and an abrasion to the medial aspect of the right knee. These injury mechanisms were evidenced by the location of the injuries relative to the (unrestrained) passenger's resulting kinematic response pattern into the driver space. The driver was reportedly entrapped by intruded lateral components requiring extensive extrication efforts by rescue personnel post-crash, however, NASS interior vehicle data suggested this was more of an issue related to jammed doors rather than specific components restricting his movement or egress from the vehicle. He was transported by ambulance to a local trauma center for treatment and admitted for 7 days.

FRONT RIGHT PASSENGER DEMOGRAPHICS

Age/Sex:	17 year old male
Height:	180 cm (71 in)
Weight:	99 kg (219 lb)
Seat Track Position:	Middle position
Manual Restraint Use:	None
Usage Source:	NASS vehicle inspection, surrogate interview, police report
Eyewear:	None
Type of Medical Treatment:	Transported to the emergency room of a local hospital for treatment and released

Front Right Passenger Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
#Nose fracture	Minor (251000.1,4)	Driver
#Contusion left upper back (near shoulder)	Minor (690402.1,2)	Driver
#Lacerations posterior left arm (multiple-small)	Minor (790602.1,2)	Flying glass

source - interviewee#

Front Right Passenger Kinematics

The unrestrained 17 year old male front right passenger of the 2000 Lincoln Town Car was presumed to be seated in an upright posture with the seat back slightly reclined and the seat track adjusted to the middle position. The NASS surrogate interview stated he was unrestrained, further evidenced by the extent of interior contact points into the driver space.

At impact with the fire hydrant, he initiated a lateral trajectory in response to the 9 o'clock impact force and loaded the center armrest and driver seat back. No specific injury was attributed to these struck components. At impact with the tree, he was out-of-position to the left and repeated a lateral trajectory in response to the 9 o'clock impact force. He again loaded the center armrest and continued the kinematic response pattern to the left as he struck the driver. This occupant-to-occupant contact resulted in a nose fracture and contusion to the left upper back, evidenced by the size and location of the injury relative to the kinematic response pattern into the driver space. He also sustained multiple (small) lacerations to the posterior aspect of the left forearm from flying glass. Following the crash, the front right passenger exited the vehicle under his own power and was transported by ambulance to the emergency room of a local hospital for treatment and released.

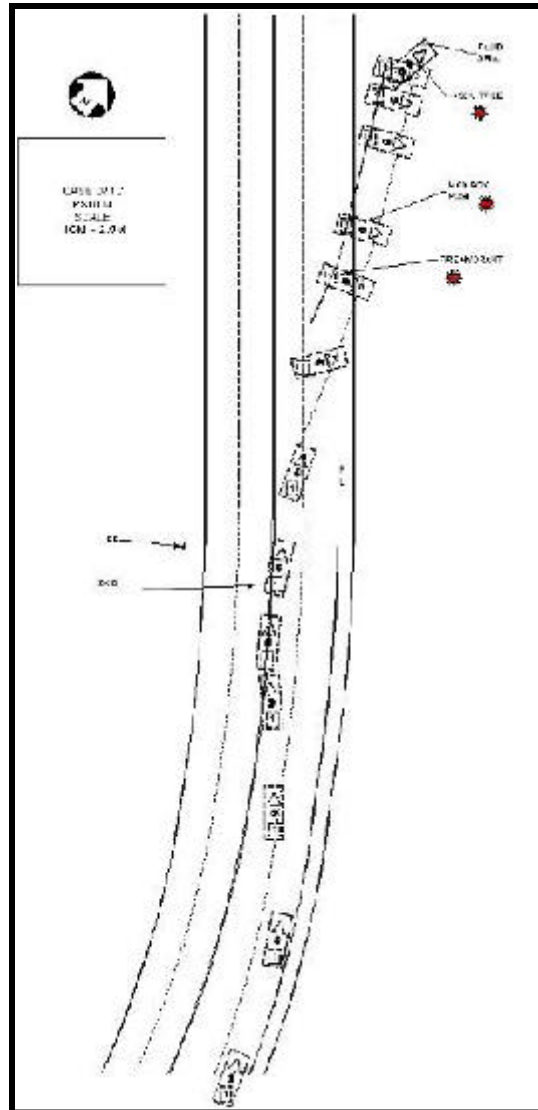


Figure 8. NASS Scene Diagram.