

**TRANSPORTATION SCIENCES
CRASH RESEARCH DATA CENTER**

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**REMOTE REDESIGNED AIR BAG DEPLOYMENT INVESTIGATION
SCI TECHNICAL SUMMARY REPORT**

VERIDIAN CASE NO. CA99-037

RABSS VEHICLE - 1998 LINCOLN TOWN CAR

LOCATION - STATE OF FLORIDA

CRASH DATE - SEPTEMBER 1998

Contract No. DTNH22-94-D-07058

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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 that involved a 1998 Lincoln Town Car equipped with redesigned frontal air bags that deployed as a result of an off-set frontal collision with a concrete median barrier. The driver of the Town Car was operating in a northerly direction in the right lane of a four-lane divided interstate when she approached a piece of tire debris in the roadway and swerved onto the right shoulder to avoid hitting the obstruction. She attempted to recover by steering left and crossed both travel lanes before she entered the left shoulder and struck the barrier with the front left area of the vehicle deploying the redesigned frontal air bag system. The vehicle rode up the barrier and was redirected in a clockwise direction. The vehicle rotated in a clockwise direction as it traveled across the two traffic lanes before coming to rest in the grass on the east shoulder. The 69-year-old female driver of the Town Car was restrained by the 3-point manual lap and shoulder belt system. She initiated a forward trajectory and loaded the manual restraint. She received police reported non-incapacitating injuries and was transported by ambulance to a local medical center for treatment. The 71-year-old male front right passenger was also restrained by the 3-point manual lap and shoulder belt system and initiated a forward/lateral trajectory. He attempted to brace against the upper instrument panel by raising his arms forward of his seated position. At impact, the front right air bag deployed and the air bag membrane contacted the anterior aspects of his forearms which resulted in bilateral abrasions of the anterior aspects of the forearms. The front right passenger loaded the manual belt webbing, which resulted in an abrasion of the right lateral neck, a faint contusion of the upper chest, and fractures of three left ribs. He probably loaded the deployed front right air bag which protected him from additional injury. He was transported by ambulance to a local medical center where he expired 3 days later due to pre-existing heart and lung disease, and blunt chest trauma as a contributing factor.</p>			
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Table of Contents

BACKGROUND	1
SUMMARY	1
Crash Site	1
Pre-Crash	2
Crash	2
Post-Crash	3
RABSS VEHICLE - 1998 Lincoln Town Car	3
VEHICLE DAMAGE - 1998 Lincoln Town Car	3
Exterior Damage	3
Interior Damage	4
REDESIGNED AIR BAG SYSTEM	4
OCCUPANT DEMOGRAPHICS	5
Driver	5
Driver Kinematics	5
Front Right Passenger	5
Front Right Passenger Injuries	6
Front Right Passenger Kinematics	6

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CRASH DATE - SEPTEMBER 1998**

BACKGROUND

This remote investigation focused on a single vehicle crash that involved a 1998 Lincoln Town Car equipped with redesigned frontal air bags that deployed as a result of an off-set frontal collision with a concrete median barrier. The driver of the Town Car was operating in a northerly direction in the right lane of a four-lane divided interstate when she approached a piece of tire debris in the roadway and swerved onto the right shoulder to avoid hitting the obstruction. She attempted to recover by steering left and crossed both travel lanes before she entered the left shoulder and struck the barrier with the front left area of the vehicle, deploying the redesigned frontal air bag system. The vehicle rode up the barrier and was redirected in a clockwise direction. The vehicle rotated in a clockwise direction as it traveled across the two travel lanes before coming to rest in the grass on the east shoulder. The 69-year-old female driver of the Town Car was restrained by the 3-point manual lap and shoulder belt system. She initiated a forward trajectory and loaded the manual restraint. She received police reported non-incapacitating injuries and was transported by ambulance to a local medical center for treatment. The 71-year-old male front right passenger was also restrained by the 3-point manual lap and shoulder belt system and initiated a forward/lateral trajectory. He attempted to brace against the upper instrument panel by raising his arms forward of his seated position. At impact, the front right air bag deployed and the air bag membrane contacted the anterior aspects of his forearms which resulted in bilateral abrasions of the anterior aspects of the forearms. The front right passenger loaded the manual belt webbing, which resulted in an abrasion of the right lateral neck, a faint contusion of the upper chest, and fractures of three left ribs. He probably loaded the deployed front right air bag which protected him from additional injury. He was transported by ambulance to a local medical center where he expired 3 days later due to pre-existing heart and lung disease, and blunt chest trauma as a contributing factor.

This crash was identified through a search of the Fatality Analysis Reporting System (FARS) for fatalities that occurred in vehicles equipped with redesigned air bags. The crash occurred in September 1998 and was assigned to the Veridian Special Crash Investigation Team of September 2, 1999 as a remote investigation effort. Police photographs and medical data were obtained which provided the basis for this narrative report.

SUMMARY

Crash Site

This single vehicle crash occurred during the daylight hours of September 1998. At the time of the crash, it was daylight with no adverse conditions as the asphalt road surface was dry. The crash occurred on an interstate highway that consisted of two northbound lanes, and two southbound lanes, separated by a concrete median barrier. The roadway was straight with a level grade. The northbound and southbound

roadside environment consisted of asphalt shoulders with tactile warning devices (rumble strips) bordering the travel lanes. The areas bordering the outboard shoulders consisted of grass and trees. The posted speed limit for this interstate was 112 km/h (70 mph).

Pre-Crash

The 69-year-old female driver of the 1998 Lincoln Town Car was operating the vehicle in the right lane of the two northbound traffic lanes of an interstate (**Figure 1**) when she approached debris from a truck tire tread lying in the outboard lane of the northbound traffic lanes. The driver initiated a right steering input to avoid the tire debris. The right side tires departed the travel lane onto the right shoulder. As the tires overrode the tactile warning devices (rumble strips), the driver applied a steering input to redirect the Lincoln back onto the outboard northbound travel lane (**Figure 2**). The subsequent steering input was excessive which induced a counterclockwise (CCW) rotation to the vehicle as its center of gravity continued in a northerly direction. The vehicle traversed the travel lanes as it continued to rotate CCW, departing the left (inboard) shoulder (**Figure 3**). Based on the police schematic, the Lincoln traveled a longitudinal distance of 66.1 meters (217.0') from the point at which the vehicle entered the right shoulder to the impact with the median barrier.



Figure 1. View looking north



Figure 2. Tire marks on right shoulder



Figure 3. Tire marks to point of impact

Crash

As the Lincoln Town Car impacted the concrete barrier, the front-left portion of the vehicle contacted the barrier approximately 46 cm (18") above the roadway (**Figure 4**). The vehicle continued into the barrier at an approximate heading angle of -45 degrees causing the entire front plane of the vehicle to contact the barrier. The principal direction of force was in the 2 o'clock sector. The impact resulted in moderate damage to the front of the vehicle. The damage algorithm of the WinSMASH program computed total velocity changes of 16.5 km/h (10.3 mph). The longitudinal and latitudinal components were -10.6 km/h (-6.3 mph) and -12.6 km/h (-7.9 mph) respectively. The impact induced deceleration was sufficient to deploy the frontal air bag system.



Figure 4. Point of impact and post impact tire marks along the median barrier

The front of the vehicle rode up the side of the barrier and was redirected into the roadway in a clockwise

direction. The lateral loading of the right rear wheel caused a fracture of the rear axle. The wheel was snagged by the brake and suspension components and dragged by the vehicle. The vehicle continued along the barrier approximately 5 meters (17') (**Figure 5**) as evidenced by considerable scuff marks from the left front wheel. The vehicle then swerved to the right induced by the right rear wheel, and traveled approximately 71 m (232') in a northerly direction back across the traffic lanes. The vehicle entered the right shoulder with the clockwise rotation diminishing as the vehicle traveled onto the grassy area adjacent to the shoulder, where it came to rest facing in an easterly direction (**Figure 6**).



Figure 5. Post impact tire marks along median barrier



Figure 6. Tire marks showing path to final rest

Post-Crash

The driver of the Lincoln Town Car was transported to a local medical center for treatment. The admission status of the driver was unknown, however, she was reported on the police report as sustaining non-incapacitating injuries. The passenger was also transported to a local medical center and initially reported on the police report to have sustained incapacitating injuries. The passenger expired three days later due to a non-crash related event.

RABSS VEHICLE - 1998 Lincoln Town Car

The 1998 Lincoln Town Car was identified by the Vehicle Identification Number (VIN): 1LNFM82W5WY (production sequence omitted). The vehicle was a 4-door sedan equipped with rear wheel drive and a 4.6L, 8 cylinder engine. The vehicle's odometer reading was unknown at the time of the crash. The police report listed the driver as the owner of the vehicle. The seating configuration was a 40/20/40 split bench front seating system with a folding storage armrest, and single bench seat with integrated folding armrest in the rear. The vehicle was equipped with a 3-point belt system for the four outboard seating positions. The front right and left 3-point belt systems featured adjustable D-ring anchors. The center seating positions for the front and rear were equipped with a lap belt only.

VEHICLE DAMAGE - 1998 Lincoln Town Car

Exterior Damage

The 1998 Lincoln Town Car sustained severe frontal damage with significant damage to the front left area (**Figure 7**). The vehicle also sustained a reduction of the left and right side the wheelbase. The Collision Deformation Classification (CDC) for this impact with the median barrier was 02-FDEW-2. The direct contact damage began at the front right bumper corner and extended approximately 149 cm (59") to the

front left bumper corner. The combined direct and induced damage spanned the full width of the vehicle (**Figure 8**). Six crush measurements were estimated at the level of the radiator support and were as follows: C1 = 38 cm (15"), C2 = 38 cm (15"), C3 = 25 cm (10"), C4 = 15 cm (6"), C5 = 8 cm (3"), C6 = 0 cm. The contact damage was limited primarily to the front plane of the vehicle. The left front wheel/tire was restricted and deflated from rearward displacement against the frame. The rear axle was fractured, and the right rear wheel was displaced (**Figure 9**).



Figure 7. Damage to the Lincoln Town Car

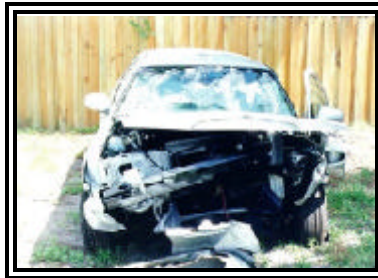


Figure 8. Frontal damage to the Lincoln Town Car



Figure 9. Displaced right rear wheel

Interior Damage

Interior damage to the Lincoln Town Car was rated as minor (**Figure 10**). There were no apparent intrusions. No deformation was identified on the knee bolster (rigid plastic type) or steering wheel rim. Blood smears were noted on the steering wheel rim, airbag, left interior door panel, left front seat, and center arm rest.

REDESIGNED AIR BAG SYSTEM

The 1998 Lincoln Town Car was equipped with redesigned air bags for the driver and front right passenger positions. The air bag system had deployed as a result of the impact with the concrete median barrier. Air bag warning labels were affixed to each sun visor. The driver's air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). Contact evidence included blood smears on the front left aspect of the air bag, however no contact evidence was identified on the exterior surface of the module cover flaps. Based on inspection of an exemplar vehicle, the flaps were asymmetrical in shape, as the upper flap measured 14.6 cm (5.8") wide and 12.7 cm (5.0") in height, while the lower flap measured 14.6 cm (5.8") wide and 2.5 cm (1.0") in height. No tether straps were identified.



Figure 10. Interior view of Lincoln Town Car

The front right passenger's air bag deployed from the right mid-instrument panel area with a single cover flap design hinged at the top aspect. No contact evidence was identified on the air bag or exterior surface

of the module cover flap. The cover flap was rectangular in shape, and measured 40.3 cm (15.9") in width and 17.5 cm (6.8") in height. No vent ports or tether straps were identified.

OCCUPANT DEMOGRAPHICS

Driver

Age/Sex:	69-year-old female
Height:	Not reported
Weight:	Not reported
Seat Track Position:	Mid-to-full rear, estimated at 23 cm rear of full forward
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Police Report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to local medical center, admission status not reported

Driver Kinematics

The 69-year-old female driver of the 1998 Lincoln Town Car was presumed to be seated in an upright posture with the seat track adjusted approximately 23 cm (9") rear of full forward position and 3 cm (1") forward of full rear position (based on an exemplar vehicle). According to the police report, she was restrained by the available 3-point lap and shoulder belt system. Based on the approximate seat position, the distance from the driver's side air bag flaps to the seat back was 56 cm (22").

At impact with the concrete barrier, the driver probably initiated a lateral and slightly forward trajectory in response to the 2 o'clock impact force and loaded the manual restraint. She subsequently loaded the deployed redesigned driver's air bag which offered additional protection from the frontal crash forces. She sustained police reported non-incapacitating injuries and transported by ambulance to a local medical center. Her admission status was not reported.

Front Right Passenger

Age/Sex:	71-year-old male
Height:	180.3 cm (71.0")
Weight:	80.9 kg (178.0 lb)
Seat Track Position:	Full rear (police photographs)
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Police Report, medical report
Eyewear:	Not reported
Type of Medical Treatment:	Transported to local medical center and expired 3 days later

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90)	Injury Mechanisms
Fracture of ribs 3-6, anterior left side	Moderate (450220.2,2)	Shoulder belt webbing
8x2cm abrasion, anterior neck	Minor (390202.1,5)	Shoulder belt webbing
Faint contusions - chest, bilateral	Minor (490402.1,3)	Shoulder belt webbing
Faint contusions - anterior forearms	Minor (790402.1,3)	Front right passenger's air bag
Faint contusion - posterior right forearm	Minor (790402.1,1)	Interior right front door

*Injury source: Autopsy report

Front Right Passenger Kinematics

The 71-year-old male passenger of the 1998 Lincoln Town Car was 180.3 cm (71.0") in height, and weighed 80.9 kg (178.0 lbs). He was presumed to be seated in an upright posture with the right front seat back adjusted to a near vertical position. The seat track appeared to be adjusted to the full rearward position. He was restrained by the available 3-point manual lap and shoulder belt system. Belt usage was confirmed by the police and medical reports, and the location and nature of his injuries. Based on approximate seat track position, the distance from the cover flap of the passenger side air bag to the seat back was 81cm (32").

The front right passenger attempted to brace against the upper instrument panel by raising his arms forward of his seated position. At impact with the concrete barrier, the passenger initiated a lateral and slightly forward trajectory in response to the 2 o'clock impact force and loaded the manual restraint system, resulting in an 8 x 2 cm obliquely oriented abrasion on the anterior neck, fractures of ribs 3 - 6 anteriorly on the left side, and faint contusions bilaterally on the upper chest. He moved toward the expanding redesigned front right passenger's air bag resulting in faint contusions on the anterior forearms. He also sustained a faint contusion on the posterior aspect of the right forearm possibly from contact with the interior right front door as the air bag expanded against the anterior aspects of his arms. He probably loaded the deployed redesigned front right passenger's air bag which protected him from additional injury. He was transported to a local medical center for treatment of his injuries, where he expired 3 days following the crash. According to the autopsy report, the cause of death was preexisting Atherosclerotic Cardiovascular Disease with contributing factors of Blunt Chest Trauma and preexisting Chronic Obstructive Pulmonary Disease.