

CRASH DATA RESEARCH CENTER

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**CALSPAN ON-SITE DRIVER AIR BAG RELATED FATALITY
INVESTIGATION**

SCI CASE NO.: CA06-014

VEHICLE: 1997 LINCOLN CONTINENTAL

LOCATION: OHIO

CRASH DATE: MAY 2006

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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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BACKGROUND

This on-site investigation focused on the severity of the crash, the nature and severity of the driver's injuries, and the source of the injuries that contributed to his death. The crash involved a 1997 Lincoln Continental that was equipped with first generation frontal air bags for the driver and front right passenger positions. The air bags deployed as a result of a front-to-rear crash with a parked step van (**Figure 1**). The 85-year old male driver of the Lincoln failed to detect the stopped step van and impacted the vehicle without initiating avoidance actions. The driver sustained fractures of C3-C4 with a laceration and contusion of the cord from expansion of the driver's air bag. He was transported by ground ambulance to a local hospital where he expired on arrival. The Lincoln was towed from the scene of the crash and transferred to an insurance auction facility where it was inspected for this investigation.



Figure 1. On-scene of the front-to-rear crash.

The driver sustained fractures of C3-C4 with a laceration and contusion of the cord from expansion of the driver's air bag. He was transported by ground ambulance to a local hospital where he expired on arrival. The Lincoln was towed from the scene of the crash and transferred to an insurance auction facility where it was inspected for this investigation.

The Calspan Special Crash Investigations team received notification of the crash on May 21, 2006 from the Fire Chief of the responding department. The notification was forwarded to NHTSA's Crash Investigation Division and assigned for on-site investigation on May 23. Cooperation was established with the Chief of the investigating police department and the insurance carrier for the Lincoln Continental. The Police Chief provided the Police Accident Report (PAR) and on-scene images of the crash to the Calspan SCI team. The vehicle was transferred to a regional auction facility where it was inspected for this SCI investigation. The delivery truck was under repair and was not available for inspection.

SUMMARY

Crash Site

The crash occurred on a two-lane roadway in a residential (**Figure 2**) area during daylight hours. At the time of the crash, the conditions were overcast and the asphalt road surface was wet due to a light rainfall. The temperature was police reported at 11 degrees C (52 degrees F). The roadway consisted of two 4 m (13') wide travel lanes delineated by double yellow centerlines and bordered by 10 cm (4") barrier curbs. Residential



Figure 2. Westbound view of the crash site.

driveways intersected the north curb line. Grass and sidewalks bordered both edges of the roadway. In the vicinity of the crash site, the road surface was straight with a one percent negative grade to the west that transitioned to a sag at the location of impact. A signalized four-leg intersection was located approximately 200 m (650') north of the crash site. The posted speed limit was 56 km/h (35 mph). There was no physical evidence at the crash site. The Crash Schematic is included as **Figure 14**, Page 10 of this report.

Vehicle Data – 1997 Lincoln Continental

The subject vehicle in this crash was a 1997 Lincoln Continental four-door sedan. The Lincoln was manufactured on 5/97 and was identified by Vehicle Identification Number (VIN) 1LNLM97V5VY (production number deleted). The front wheel drive Lincoln was powered by a 4.6 liter, 32-valve, Intech V-8 engine, linked to four-speed automatic transmission with overdrive and traction control. The transmission selector lever was mounted within the fixed center console. The service brakes were four-wheel disc with anti-lock (ABS). The Continental was equipped with OEM alloy wheels and Cooper Lifeline STE all-season radial tires, size P225/60R16. The maximum tire pressure was 300 kPa (44 PSI) while the vehicle manufacturer recommended cold tire pressure was 207 kPa (30 PSI) for the front and 193 kPa (28 PSI) for the rear tires. The measured tire data at the time of the SCI inspection is identified in the following table:

Position	Measured Pressure	Measured Tread Depth	Damage
Left Front	221 kPa (32 PSI)	7 mm (9/32")	None
Left Rear	186 kPa (27 PSI)	6 mm (7/32")	None
Right Front	221 kPa (32 PSI)	5 mm (6/32")	None
Right Rear	221 kPa (32 PSI)	5 mm (6/32")	None

The interior of the Continental was configured with leather covered front bucket seats and a three-passenger rear fixed bench seat. The front seats were 8-way power adjustable with adjustable head restraints. Both front head restraints were in the full-down positions at the time of the crash. The interior features included power windows, power door locks, and power adjustable outside mirrors. The center console was configured with an integrated armrest and storage compartment that was positioned high with respect to the front seat cushions. The safety equipment included first generation frontal air bags for the driver and front right passenger positions and 3-point lap and shoulder belts for the five designated positions.

1991 International Chassis/Step Van

The struck vehicle in this case was a 1991 International chassis with a step van body. The vehicle was configured with snub-nose cab with a front mounted engine, two sliding doors for the cab, and a roll-up rear door for the cargo area. A rear step bumper was mounted to the body/cargo box of the van. This vehicle was under repair at the time of the SCI investigation and was not available for inspection.

Crash Sequence

Pre-Crash

The 85-year old male driver of the Lincoln was traveling in a southerly direction on the two lane roadway during daylight hours. He stopped for a red signal phase at a four-leg intersection that was located approximately 200 m (650') north of the crash site. As the overhead signal cycled to green for north/southbound traffic, the driver accelerated in a southerly direction. The conditions were overcast with a light rain; however, the reporting Fire Chief noted that this did not impede the driver's line of sight.

The driver of a delivery step van stopped his vehicle adjacent to the right curb line of the southbound travel lane. He placed the vehicle in park, activated the emergency flashers on the vehicle, and unfastened his safety belt system as he prepared to exit the vehicle and make a routine delivery to a residence located at the west (right) road side.

The driver of the Lincoln was either inattentive or failed to detect the stopped delivery truck. He did not initiate avoidance action(s) as he approached the back of the parked delivery van. A witness following the Lincoln stated to the investigating officer that there were no brake lights illuminated on the Lincoln pre-crash. The Lincoln did not deviate from the center of the travel lane prior to impact. There was no physical evidence at the crash site to support possible avoidance action.

Crash

The front center and right area of the Lincoln Continental impacted the back left bumper area of the delivery van in the center of the southbound travel lane. The resultant directions of force were 12 o'clock for the Lincoln and 6 o'clock for the struck step van. This impact crushed the front bumper beam of the Lincoln and deployed the frontal air bag system.

The impact displaced the step van forward to a driver reported distance of approximately 2 m (6'). As a result of this impact, the Continental's bumper fascia separated from the vehicle and fell onto the road surface. The Lincoln continued forward and overrode the fascia. The Lincoln subsequently re-engaged the back of the step van and came to rest. The secondary contact was minor in severity and overlapped the initial damage and did not alter the crush profile. The WINSMASH program computed a barrier equivalent velocity change of 20 km/h (12.4 mph) for the Lincoln based on the residual damage.

Post-Crash

The Lincoln came to rest engaged against the back of the struck step van with the engine running. The driver of the Lincoln rebounded into the right seat back and slumped over the center console with his upper torso and head resting on the front right seat cushion.

A witness to the crash stopped his vehicle behind the Lincoln and approached the Continental to check on the condition of the driver. He observed the driver slumped to the right and unrestrained with the deployed front passenger air bag partially covering the driver's head. All four doors of the Lincoln were locked at the time of the crash. This

witness asked the driver if he required medical help and the driver apparently nodded his head slightly to indicate yes. A call was placed to the 911 system for police and rescue assistance.

The City professional fire department arrived on-scene with police arriving within six minutes of the call for assistance. Fire department personnel observed the driver unresponsive in the vehicle and shattered the left rear door window to gain access to the driver. The ignition was turned off and the driver was evaluated and prepared for removal from the vehicle. A cervical collar was applied and he was placed on a backboard and transferred to the ground ambulance. CPR activities were initiated, an IV was placed in his arm, and attempts to intubate the driver for respiratory purposes were unsuccessful. He was transported to a local hospital where he expired following arrival.

The Lincoln Continental was towed from the scene and impounded by police for a safety inspection. The delivery step van was emptied of its contents at the scene and towed for a police safety check. This vehicle was released for repair. The Continental was released by the police and transferred to an insurance salvage yard where it was inspected for this SCI investigation.

Vehicle Damage

Exterior – 1997 Lincoln Continental

The frontal area of the Lincoln sustained moderate severity damage as a result of the engagement against the back of the struck step van. Although the bumper fascia separated and was run over by the Lincoln, the impact related direct contact damage on the fascia began 6 cm (2.5”) left of center and extended 76 cm (30”) to the right bumper corner. Maximum crush was measured at 37 cm (14.6”) located on the front bumper beam 13 cm (5”) right of center. The impact fractured and separated the fascia and energy absorbing foam from the bumper, deformed the bumper beam to a V-shape, fractured the grill and gouged the fiberglass hood (**Figure 3**). The crush profile was documented at the level of the bumper beam using a combined induced and damage length of 130 cm (51.25”). The crush profile (**Figure 4**) was as follows: C1 = 0 cm, C2 = 5 cm (2”), C3 = 10 cm (4”), C4 = 34 cm (13.5”), C5 = 19 cm (7.4”), C6 = 10 cm (3.75”). The Collision Deformation Classification (CDC) for this impact was 12-FZEW-2.



Figure 3. Frontal damage to the Lincoln Continental.



Figure 4. Overhead view documenting the extent of frontal crush.

The bumper fascia separated and fell onto the road surface and was subsequently run over by the undercarriage and the front tires of the Continental. The fascia was abraded full width from contact with the road surface (**Figure 5**).



Figure 5. Separated bumper fascia.

The Lincoln continued forward and struck the same back left area of the step van with the deformed frontal area of the Continental. This secondary impact/contact was overlapping and did not alter the initial crush profile to the Lincoln. A second CDC of 12-FZEW-1 was assigned to reflect this secondary engagement. This event was supported by the on-scene images of the crash and depicted in **Figure 1**.

The windshield was fractured from contact by the front right air bag module cover flap. All remaining glass was intact post-crash. The left rear door glazing was shattered by the fire department personnel to gain access to the interior of the Lincoln. All four doors remained closed and were operational post-crash.

The right side of the Lincoln had previous sideswipe-type damage that extended from the right A-pillar area, along both doors onto the lower C-pillar area and terminating on the right side aspect of the rear bumper corner. Touch-up paint was prevalent on the lower C-pillar area. This damage was not related to this crash.

Interior – 1997 Lincoln Continental

The interior of the Lincoln sustained minor severity damage that was associated with deployment of the frontal air bag system and driver contact. The interior was not damaged by exterior deformation and there was no reduction in size of the passenger compartment.

The driver was within the path of the deploying and expanding front left air bag. There was no damage or contact evidence to the air bag membrane. The steering assembly was free of damage and compression. The expanding air bag displaced the driver vertically into the left sun visor (**Figure 6**). The visor remained in its stowed position, engaged into the inboard locking tab. The driver's head impacted the exposed surface of the visor. There was no damage visible to this side (**Figure 7**). His loading fractured the integrated vanity mirror (**Figure 9**) which was only visible by pivoting the visor and opening the plastic cover that concealed the mirror. There was no other damage to the top side of the visor (**Figure 8**).

The interior mounted rear view mirror was deflected to the left which may have resulted from a fling contact by the right upper extremity of the driver. This mirror deflection could have also resulted from air bag expansion or inadvertent contact during the removal of the driver. There was no contact evidence to support the source of this deflection.



Figure 6. Impacted left sun visor.



Figure 7. Edge view of the non-distorted visor.



Figure 8. Top side of the visor; vanity mirror not damaged.



Figure 9. Fractured vanity mirror.

Several blood spatters were noted to the interior surfaces of the Continental. The involved components included the forward aspect of the driver's door panel, the left outboard trim panel of the driver's seat cushion, the upper inboard aspect of the left front seat back, the inboard side of the front left head restraint, the upper inboard aspect of the front right seat back, and the front right seat cushion.

Exterior – 1991 International Chassis/Step Van

The rear bumper of the step van sustained minor severity damage as a result of the crash (**Figure 9**). This was based on the on-scene images of the vehicle that were provided to the SCI team. The left aspect of the bumper was minimally crushed and a mounting bracket was separated above the level of the bumper. Additionally, the back wall and the floor area of the cargo box were crushed forward, estimated at 5 cm (2"). The step van was towed from the scene for a police required safety inspection. The minor severity damage to the rear of the vehicle did not require towing.



Figure 10. Damage to the rear of the struck step van.

Frontal Air Bag System – 1997 Lincoln Continental

The 1997 Lincoln Continental was equipped with first generation frontal air bags for the driver and front right passenger positions. This system consisted of a steering wheel mounted driver air bag module, a front right passenger air bag module that was incorporated into the top and mid right instrument panel, a transmission tunnel (interior) Restraints Control Module (RCM), and two electro-mechanical crash sensors that were mounted on brackets attached to the forward aspect of the upper radiator support. The left sensor was not directly involved in this crash; however, the right sensor was rotated to the left by direct contact during the crash. The sensor cover was not crushed or deformed.

The driver's air bag was concealed by a single cover flap that was hinged at the top aspect. The overall dimensions of the cover flap measured 15 cm (6") vertically and 19 cm (7.4") horizontally. The top hinge was 7 cm (2.75") in width. There was no driver contact evidence or damage to the vinyl flap.

The driver's air bag deployed from the module as designed (**Figure 11**). The air bag membrane measured 61 cm (24") in diameter in its deflated state and was tethered internally by two straps at the 12 and 6 o'clock positions. The tethers were sewn to the face of the air bag with a 17 cm (6.75") stitch pattern. The air bag was vented by two 2 cm (0.6") diameter ports located on the back side of the bag at the 11 and 1 o'clock positions. The ports were centered 6 cm (2.5") forward of the peripheral seam. The following nomenclature was stamped on the face of the air bag:

020752R



Figure 11. Deployed driver's air bag.



Figure 12. Front mounted air bag crash sensors.

The front right passenger air bag was concealed by a single cover flap that was hinged at the top of the right instrument panel. The flap was contoured to the mid panel where the horizontal tear seam was designed. The vinyl cover flap opened upward and forward

during the deployment of the front right air bag. The leading edge of the cover flap impacted and fractured the laminated windshield.

The front right passenger air bag was not tethered or directly vented into the passenger compartment. The air bag was not damaged and was not contacted by the driver.

The RCM of the Lincoln was not supported by the Vetronix Crash Data Retrieval tool; therefore stored data was not commercially downloadable. The RCM monitored the safety system for potential faults and commanded the deployment of the frontal air bag system following closure of the front mounted crash sensor(s) and the safing sensor. The Lincoln retained electrical power at the time of the SCI inspection. With the ignition key turned to the on-position, the instrument panel mounted air bag warning lamp illuminated for a period of six seconds followed by a flash cycle of three flashes followed by two flashes. This sequence would repeat for a series of five flash cycles prior to a constant light.

Manual Safety Belt Systems – 1997 Lincoln Continental

The Lincoln was configured as a five-passenger vehicle with two front positions and a three-passenger rear bench seat. The driver was the sole occupant in the vehicle. He was not restrained by the manual safety belt system. The driver was observed in the vehicle post-crash as unrestrained and there was no loading evidence to the safety belt system.

The driver's belt system consisted of a continuous loop webbing with a sliding latch plate that retracted onto an Emergency Locking Retractor (ELR) with a webbing sensitive locking mode. The belt system displayed minimal evidence of routine wear. The front right belt system utilized a switchable ELR/Automatic Locking Retractor (ALR). Both front safety belt systems were equipped with adjustable D-rings that were adjusted to the full-up positions.

The rear seat was equipped with 3-point lap and shoulder belt systems for the three designated positions. All three belts utilized continuous loop webbings, sliding latch plates, and switchable ELR/ALR retractors.

Occupant Demographics/Data

Driver – 1997 Lincoln Continental

Age/Sex:	85-year old/Male
Height:	175 cm (69")
Weight:	71 kg (156 lb)
Manual Restraint Usage:	None
Usage Source:	Vehicle inspection
Seat Track Position:	Rear track
Eyewear:	Prescription eyeglasses
Egress From Vehicle:	Removed by paramedics
Type of Medical Treatment:	Transported by ambulance to a local hospital where he expired on arrival

Driver Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Source
Cervical spine fracture at C3/C4 with dislocation and laceration of the spinal cord	Critical (640250.5,6)	Deploying driver's frontal air bag
Contusion of the spinal cord (NFS)	Serious (640200.3,6)	Deploying driver's frontal air bag
5x5 cm abrasion of the forehead	Minor (290202.1,7)	Left sunvisor
Small lacerations of the dorsal surface of the left hand	Minor (790602.1,2)	Left door panel
10x10 cm subgaleal hematoma	Minor (190402.1,9)	Left sunvisor/roof

Source – Autopsy Report

Driver Kinematics

The 85-year old male driver of the 1997 Lincoln Continental was seated in a presumed upright posture with the power seat adjusted to a rear track position. The seat back was found reclined to 22 degrees aft of vertical at the time of the SCI inspection. The tilt steering wheel was adjusted to a mid position. In these adjusted positions, the horizontal distance between the center of the driver's air bag module cover flap and the seat back was 62 cm (24.5"), measured 43 cm (17") above the seat bight. The driver was not restrained by the manual safety belt system. He was observed unrestrained in the vehicle by witnesses and the first responders. The belt system did not yield evidence of loading, but did yield evidence of occasional historical usage.

At impact with the delivery truck, the Lincoln's first generation frontal air bag system deployed. The air bag expanded against the driver's left forearm which displaced his hand from the proximity of the steering wheel. His hand was thrust into the left door panel which resulted in small lacerations of the dorsal aspect of the hand.

The driver initiated a forward trajectory into the path of the expanding driver's air bag. The air bag expanded against the underside of the driver's chin which hyperextended the neck resulting in fractures of C3/C4 with a laceration and contusion of the spinal cord.

The expansion of the air bag displaced the driver vertically into the sun visor (**Figure 13**). His contact with the visor did not produce contact evidence to the



Figure 13. Driver's vertical displacement into the sun visor.

exposed face of the visor; however, the integrated vanity mirror glass was fractured. The driver sustained an abrasion of the forehead from the visor contact. As he compressed the visor against the headliner, the mirror fractured. The visor/roof contact resulted in a 10x10 cm subgaleal hematoma.

There was no driver contact points noted to the knee bolster or the steering wheel rim/column. The steering wheel rim, mounting flange and column shear capsules were not damaged or compressed. Several blood droplets were noted to the left front door panel, outboard aspect of the driver's seat, and the right front seat back and seat cushion.

Based on the blood evidence within the vehicle, the driver probably rebounded into the seat back and subsequently slumped to his right onto the front right seat cushion where he came to rest.

The driver was removed from the vehicle by the fire department paramedics and transported by ground ambulance to a local hospital where he expired following arrival. CPR was administered at the scene and continued during the ground ambulance transport.

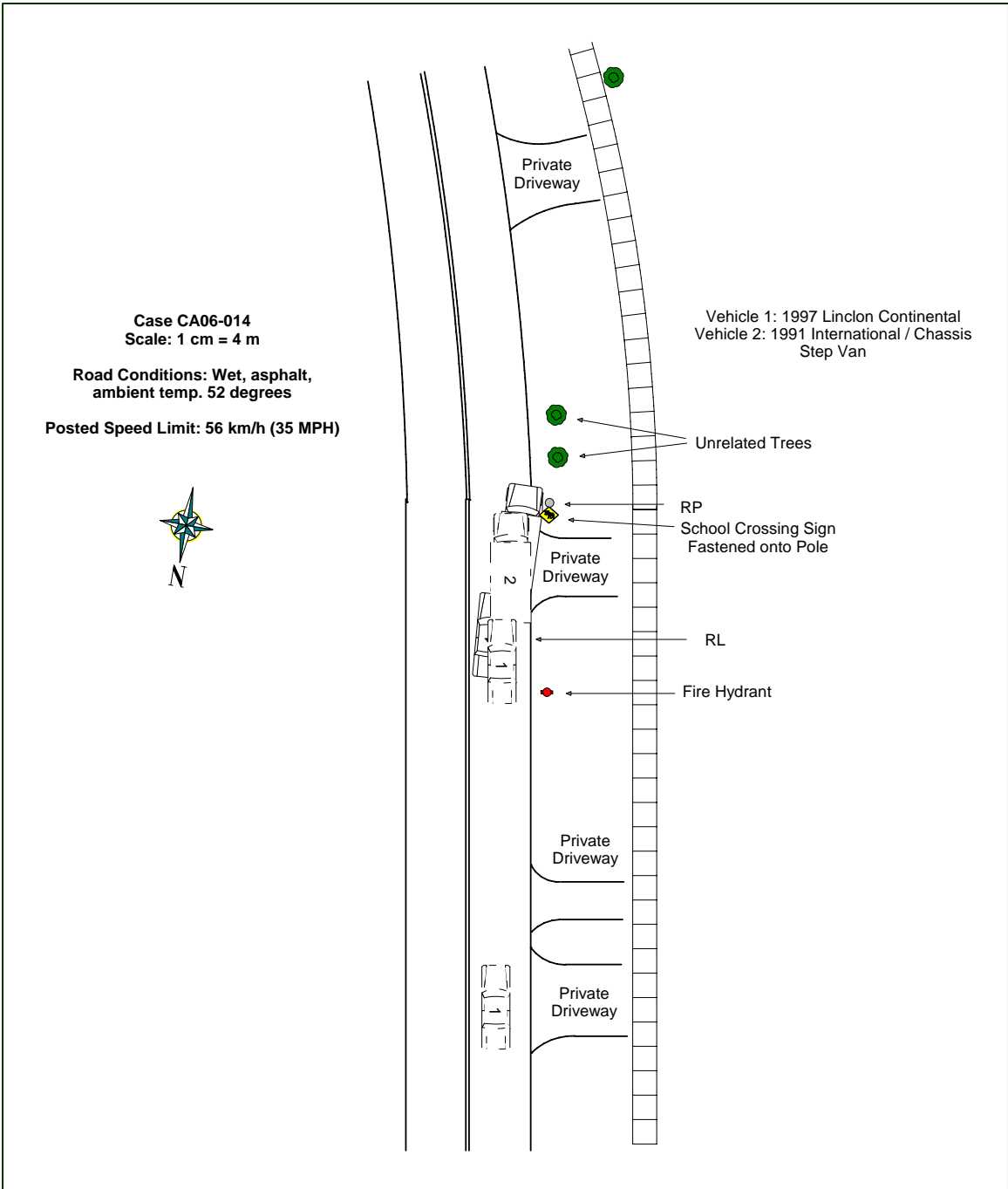


Figure 14. Crash Schematic.