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ON-SITE REAR IMPACT CRASH AND FIRE INVESTIGATION

VEHICLE: 1998 LINCOLN TOWN CAR LIMOUSINE

CASE NO: CA03-053

LOCATION: NORTH CAROLINA

CRASH DATE: SEPTEMBER, 2003

Contract No. DTNH22-01-C-17002

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 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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No. CA03-053	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle On-site Rear Impact Crash and Fire Investigation Vehicle: 1998 Lincoln Town Car Limousine Location: North Carolina		*5. Report Date*: January 2004	
		6. Performing Organization Code	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Transportation Sciences Crash Data Research Center Advanced Information Engineering Services P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0155	
		11. Contract or Grant No. DTNH22-01-C-17002	
12. Sponsoring Agency Name and Address U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		*13. Type of Report and Period Covered* Technical Report Crash Date: September 2003	
		14. Sponsoring Agency Code	
15. Supplementary Note On-site investigation of a rear impact crash and crash-induced fire in a 1998 Lincoln Town Car Limousine that resulted in the deaths of three female occupants.			

16. Abstract

This investigation focused on the vehicle compliance issues, fuel system failure and injury mechanisms that resulted in the death of three female occupants (ages 29, 24 and 16) riding in a 1998 Lincoln Town Car Limousine. The Lincoln was involved in a severe rear-impact crash with a 1998 Ford F150 pick-up truck. The limousine was then displaced forward into a secondary front-to-rear impact with a stopped 1997 Ford Escort. The fuel tank in the Lincoln ruptured as a result of the rear impact crash and a post-crash fire developed. The driver of the limousine was able to exit the vehicle through the front left door, however, he was unable to approach the vehicle and lend any form of assistance to the passengers due to the developing fire. The female occupants were reportedly trapped within the passenger compartment of the limousine and died in the ensuing fire. The medical examiner reported that the cause of death of the three occupants was thermal burns and smoke inhalation. The 42 year old male driver of the limousine and the 35 year old male driver of the Ford sustained police reported C-type (possible) injuries.

The Special Crash Investigations team at Veridian Engineering identified this crash through an internet news search and forwarded that information to the Crash Investigation Division of the National Highway Traffic Safety Administration on September 15, 2003. NHTSA assigned an on-site investigation of the crash to the Veridian SCI team due to the continued interest in the crash induced fire issue of the Ford Crown Victoria/Lincoln Town Car platform and the agency's interest in the safety compliance of the limousine. Upon case assignment, cooperation with the local police investigators was established. Both vehicles were impounded pending criminal charges and were available for SCI inspection. A joint inspection with technical representatives of Ford Motor Company and the local police investigators took place on Monday, September 22, 2003.

17. Key Words Limousine Limousine conversion Rear impact Crash induced Fire Thermal burns Smoke inhalation		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 14	*22. Price*

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VEHICLE: 1998 LINCOLN TOWN CAR LIMOUSINE
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BACKGROUND

This investigation focused on the vehicle compliance issues, fuel system failure and injury mechanisms that resulted in the death of three female occupants (ages 16, 24 and 29) riding in a 1998 Lincoln Town Car Limousine, **Figure 1**. The Lincoln was involved in a severe rear-impact crash with a 1998 Ford F150 pick-up truck. The limousine was then displaced forward into a secondary front-to-rear impact with a stopped 1997 Ford Escort. The fuel tank in the Lincoln ruptured as a result of the rear impact crash and a post-crash fire developed. The driver of the limousine was able to exit the vehicle through the front left door, however, he was unable to approach the vehicle and lend any form of assistance to the passengers due to the developing fire. The female occupants were reportedly trapped within the passenger compartment of the limousine and died in the ensuing fire. The medical examiner reported that the cause of death of the three occupants was thermal burns and smoke inhalation. The 42 year old male driver of the limousine and the 35 year old male driver of the Ford sustained police reported C-type (possible) injuries.

Figure 1: Left front view of the DaBryan limousine.

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SUMMARY

Crash Site

This crash occurred during the nighttime hours of September, 2003. At the time of the crash, it was dark with artificial overhead lighting. The weather was clear and was not a factor. The crash occurred in the westbound lanes of an interstate highway in an urban area. At the crash site, the westbound roadway was configured with four lanes; three lanes were for westbound

traffic with the outboard (right) lane designated for traffic exiting the highway. There was an active work/construction zone approximately 0.3 km (0.5 mile) west of the crash site. The construction involved repaving the road and, as a result, the through traffic lanes were being tapered from three to two. This caused a back-up in traffic that was reportedly stopped. The speed limit in the area of the crash was 89 km/h (55 mph). **Figures 2 and 3** are views of the westbound lanes of the interstate taken from an overpass located above the area of impact. **Figure 4** is a view of the area of impact from the north shoulder.

Figure 2: Look back view along the westbound lanes leading into the area of impact.

Figure 3: Westbound view of the repaving project.

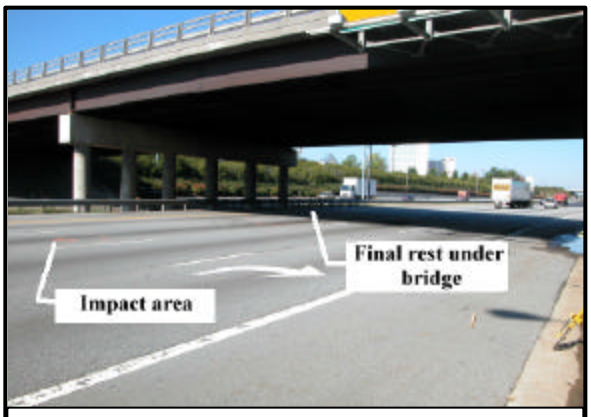

Figure 4: View of the impact zone and final rest.

CRASH SEQUENCE

Pre-Crash

The 1998 Lincoln Town Car Limousine was westbound driven by a 42 year old restrained male. The limousine's passenger compartment was occupied by three females, ages 16, 24, and 29. The driver did not have any knowledge regarding the seating positions of the passengers. It

could not be determined if these occupants were restrained by safety belts due to the circumstances of the fire. The driver reportedly had just entered the interstate approximately 3 km (2 miles) east of the construction zone and was en-route returning the passengers to their homes located several hours away in another region of the state. He reported the fuel tank was approximately half full [38 liters (10 gallons)]. The privacy glass was in the up position.

The driver of the limousine braked the vehicle to a controlled stop on the approach to the construction zone behind a line of stopped traffic on the center through travel lane. A 1997 Ford Escort was stopped directly ahead of the limousine. The Escort was occupied by a 55 year old male driver and a 69 year old female front right passenger. Approaching these vehicles was a westbound 1998 Ford F150 pick-up truck driven by an unrestrained 35 year old male. Witnesses reported the Ford F150 had passed several non-contact vehicles and was traveling in excess of the 89 km/h (55 mph) speed limit. These witnesses reported the visibility toward the stopped traffic was unobstructed.

Crash

The crash occurred when the driver of the Ford F150 failed to recognize the stopped traffic and the front of the Ford struck the rear of the limousine in a (slight) offset 12/6 o'clock impact configuration. The police investigation determined the Ford driver was alcohol impaired. The velocity changes (delta V) calculated by the Damage Algorithm of the WINSMASH model for the Lincoln and Ford were 38.2 km/h (23.7 mph) and 57.5 km/h (35.7 mph), respectively. During the rear impact and crush, the fuel tank on the limousine ruptured and a post-crash fire developed.

The westbound momentum of the Ford F150 displaced the limousine forward and into a front-to-rear impact sequence with the stopped Ford Escort. The calculated delta V's for the Lincoln and Ford Escort were 9.8 km/h (6.1 mph) and 22.0 km/h (13.6 mph), respectively. The Ford Pick-up separated from the limousine and rotated approximately 60 degrees counterclockwise coming to rest, straddling lanes three and four, 14 m (45 ft) from the initial point of impact. The Lincoln and Ford Escort were displaced forward approximately 15 m (51 feet) west of the point of impact and came to rest within their original travel lane (lane three). The driver of the Ford Escort then drove his vehicle forward and off the right side of the highway to escape the developing fire. **Figure 20** at the end of this report is a schematic of the crash.

Post-Crash

The limousine driver reported in his police interview he was unaware of the impending crash. He felt the impact as the vehicle accelerated forward; then felt an intense rush of heat. He exited the vehicle through the left front door. However, the heat and flames from the fuel fed fire were too intense and he was not able to render aid to the three occupants. As a result of the crash forces, the vehicle deformation had jammed the rear doors of the limousine shut. The three female occupants succumbed in the fire. An autopsy of the occupants was conducted the day following the crash. The medical examiner reported that the occupants' cause of death was thermal burns and smoke inhalation.

VEHICLE DATA

1998 Lincoln Town Car Limousine

The 1998 Lincoln Town Car was identified by the Vehicle Identification Number (VIN): 1L1FM81W5WY (production sequence deleted). The subject vehicle was a 305 cm (120 in) stretch of the base model rear-wheel drive Lincoln Town Car. The Lincoln, **Figure 4**, was altered by DaBryan Coach Builders Inc., Springfield, MO. The limousine's Gross Vehicle Weight Rating (GVWR) was 3,221 kg (7,100 lb). Reportedly, the stretched Lincoln was rated to carry eight passengers (driver and front occupant excluded). The seating capacity of the vehicle was limited by the GVWR, not the number of available seat positions. The base model Lincoln Town Car was a body-on-frame design and had an original overall length of 546.9 cm (215.3 in) with a 298.2 cm (117.4 in) wheelbase. The power train consisted of a 4.6 liter/V8 engine linked to a 4-speed automatic transmission. The service brakes were front disc/rear drum with 4-channel ABS. The front tires were Goodyear Integrity P225/70R16 radial tires mounted on alloy rims. The rear tires were consumed in the fire. The fuel capacity was 72 liters (19 gallons). The left front door was jammed shut at the time of the inspection and the manufacturers and alteration labels were inaccessible. Visual inspection along the left B-pillar and left door frame indicated the labels were consumed in the fire. A label located within the engine compartment (attached to the underside of the hood) indicated the vehicle was painted on August 2, 1998. This label was a probable indicator of the time frame for the completion of the modifications. The vehicle's mileage at the time of the crash could not be determined.

Figure 4: Left front view of the DaBryan limousine.

Limousine Conversion

The subject vehicle was a 305 cm (120 in) conversion manufactured by DaBryan Coachbuilders Inc., http://www.debryancoach.com. DaBryan Coachbuilders was a member of Ford Motor Company's Quality Vehicle Manufacturing (QVM) program. QVM manufacturers are successfully evaluated by Ford on criteria related, but not limited to; engineering, manufacturing process, quality control, and adherence to guidelines. Vehicles produced through the QVM program are required to be in compliance with all applicable Federal Motor Vehicle Safety Standards (FMVSS), conformance to all Ford and Lincoln industry guidelines, and annual facility inspection and review.

Figures 5 and 6 are the left and right side views of the limousine, respectively. The vehicle modifications consisted of splitting the vehicle 9.9 cm (3.9 in) aft of the OEM B-pillar and stretching the vehicle 305 cm (120 in). This was completed by the insertion of C- and D-pillars, roof rails, lower sills and frame extension. The B-pillar to C-pillar measurement was 151.1 cm (59.5 in) measured at the beltline. The C-pillar to D-pillar measurement was 160.0 cm (60.3 in). The OEM rear doors were hinged on the inserted D-pillar. The side structure was reinforced by a 3.5 cm (1-3/8 in) OD tubing welded to brackets attached to aft edge of the B-pillar, C-pillar, and to the forward edge of the D-pillar. The roof was spliced together with a 115.3 cm x 308.1

cm x 0.31 cm (45.4 in x 121.3 in x 1/8th in) steel panel. There was no (mechanical) impact damage to the limousine forward of the B-pillars/rear doors. There was no separation of any welds in the modification. The exterior body panel of the limousine was a 305 cm (120 in) continuous aluminum panel that was formed to the original contour of the vehicle. The right side panel was consumed in the fire and the left side panel was partially melted.

All the side window glazings had disintegrated, presumably due to the heat of the fire. The side windows measured 138.4 cm x 43.2 cm (54.5 in x 17.0 in). An 86 cm x 43 cm (34 in x 17 in) sunroof was located immediately forward of the D-pillar. Its glazing had disintegrated. The sunroof appeared to be fixed; there was no identified mechanism that would have allowed this roof window to open.

Figure 5: Left side view of the limousine.

Figure 6: Right side view.

Exterior Damage

Figures 7 through 9 are the rear, left lateral and right lateral views of the Lincoln. The vehicle sustained severe fire damage from the back plane forward to the A-pillars. The back plane of the vehicle sustained 157 cm (62 in) of direct and induced damage that extended across the vehicle's end width. The width of the direct damage measured 107 cm (42 in) and it began 28 cm (11 in) left of center extending to the right rear corner. The direct contact damage was biased to the right indicative of the offset impact configuration. The Ford's front bumper impacted the Lincoln's rear bumper causing longitudinal deformation of the Lincoln's bumper structure, rear frame members, rear quarterpanels and a complete collapse of the trunk. During the impact sequence the Ford F150's bumper overrode the Lincoln's rear bumper resulting in the deepest penetration at the elevation of the rear trunk body line. The rear deformation jammed both doors shut.

The rear crush profile was documented along the rear bumper reinforcement and rear trunk body line. The crush profile measured along the bumper reinforcement was as follows: C1 = 77.0 cm (30.3 in), C2 = 105.0 cm (41.3 in), C3 = 131.0 cm (51.6 in), C4 = 116.0 cm (45.7 in), C5 = 108.0 cm (42.5 in), C6 = 92.0 cm (36.2 in). The longitudinal displacement (crush) of the left and right EAD's of the rear bumper measured 76.4 cm (30.1 in) and 91.1 cm (35.9 in), respectively. The right EAD compressed its entire 3.48 cm (1.38 in) stroke and was jammed. The left EAD stroke

measured 2.0 cm (0.8 in). The crush profile documented along the rear trunk edge was as follows: C1 = 58.0 cm (22.8 in), C2 = 87.0 cm (34.3 in), C3 = 102.0 cm (40.2 in), C4 = 107.0 cm (42.1 in), C5 = 107.0 cm (42.1 in), C6 = 112.0 cm (44.1 in). An impression of the left front frame rail end of the Ford F150 was identified on the approximate centerline of the Lincoln at the elevation of the crush profile. The trunk lid buckled and was displaced forward through the backlight. The reduction of the left and right wheelbase measurements were 3.8 cm (1.5 in) and 17.3 cm (6.8 in), respectively. The rear doors were jammed shut. The right rear door panel overlapped the right rear quarterpanel sheet metal 5 cm (2 in) due to the rear deformation. An average of the aforementioned crush profiles was used to quantify the crash severity using the Damage Algorithm of the WINSMASH model. The calculated delta V calculated was 38.2 km/h (23.7 mph). The longitudinal and lateral components were +38.2 km/h (+23.7 mph) and 0, respectively. The Collision Deformation Classification (CDC) was 06-BZEW-6.

Figure 7: Rear view of the Lincoln.

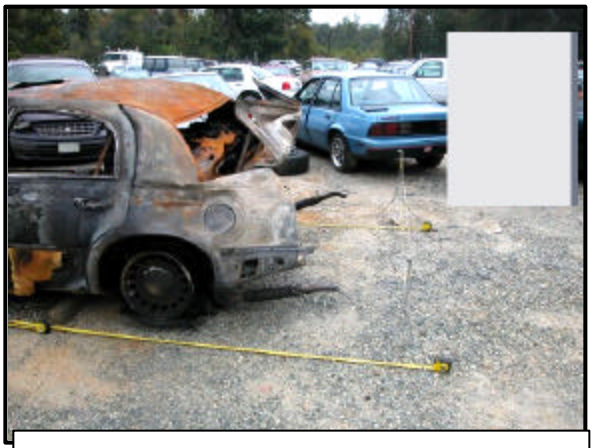

Figure 8: Left lateral view

Figure 9: Right lateral view across the back plane.

The front bumper of the Lincoln, **Figure 10**, sustained 84.6 cm (33.3 in) of direct contact damage during its secondary collision with the rear of the Ford Escort. The direct contact began 8.9 cm (3.5 in) right of center and extended to the left corner. The damage consisted of abrasions to the bumper fascia and displacement of the fascia wrap-around at the left corner. There was no residual crush of the front bumper reinforcement. There was no damage to the headlamp assemblies, hood or upper radiator support. The center grille had separated in the impact. The CDC of this minor impact was 12-FYLW-1. The calculated longitudinal delta V was -9.8 km/h (-6.1 mph). This minor front crash was below the threshold to warrant deployment of the Lincoln's frontal air bag system. Inspection of the front interior revealed the front right passenger air bag was still packed within the module and melted due to the fire. The steering wheel and driver air bag module were consumed by the fire.

Figure 10: Front view of the Lincoln.

Interior Damage

Figures 11 through 13 are interior views of the limousine. The seating system in the passenger compartment of the limousine was configured in as an elongated C (viewed from overhead). The OEM forward-facing rear three-passenger bench seat of the Lincoln formed the base of the C. The width of the seat frame measured 130 cm (51 in). A 143.5 cm (56.5 in) long three-passenger aftermarket bench seat was mounted along the left side of the compartment facing to the right. A 130 cm (51 in) wide rear-facing three-passenger bench seat was mounted aft of the privacy glass. All three bench seats had fold-down center arm rests. A solid hardwood handcrafted console was mounted longitudinally along the right side. The entire contents of the interior were consumed in the fire. Inspection of the forward aspect of the right rear wheel opening identified an opening in the deformed body panels that led into the occupant compartment. This void created a direct path for the fire to enter the compartment.

Figure 11: Rear forward facing OEM seat.

All the safety belts systems in the limousine were destroyed in the fire. The rear forward facing seat was equipped with OEM 3-point lap and shoulder belts for the outboard positions and an OEM center lap belt. Media research conducted by this investigator indicated the right side facing and forward rear facing seat were equipped with after-market lap belts for those six seat positions.

Figure 12: Rear facing forward seat.

Figure 13: Right side facing longitudinal seat.

The driver reported that he had raised the privacy window that separated the driver and passenger compartments. The privacy window was mounted immediately behind the driver and front right passenger seats to a weldment comprised of 2.5 cm x 5.0 cm (1.0 in x 2.0 in) rectangular stock attached to the B-pillars, **Figures 14 and 15**. The approximate dimensions of the window measured 44.5 cm x 128.3 cm (17.5 in x 50.5 in). The window was powered by an electric motor and moved vertically via a geared linkage.

Figure 14: Front compartment and privacy glass.

Figure 15: Lateral view of the privacy glass mount.

Fuel System and fire

The fuel tank in the Lincoln was located immediately forward of the trunk well, approximately 25 cm (10 in) behind the rear axle. The tank is secured to the front wall of the trunk by two band straps attached to the upper and lower aspects of the wall. The tank was steel and had a capacity

of approximately 72 liters (19 gallons). The fuel level in the subject vehicle was reportedly half-full at the time of the crash.

During the vehicle inspection, the rear end of the Lincoln was raised and an examination of the fuel tank was conducted. Based on the inspection and observation of the fuel tank and the identification of the rupture points, the SCI team decided not to remove the fuel tank from the vehicle.

The fuel tank was severely crushed from the left attachment strap to its right end. The width of this region measured 89 cm (35 in). The extent of the crush was approximately the full thickness of the tank. The fuel tank was punctured on the bottom right forward corner from contact with the right rear suspension and drive axle. The puncture was a vertical slit that measured 50mm x 6 mm (2 in x 0.25 in), **Figure 16**. Above and outboard of the slit, was a second puncture that measured 6 mm x 3 mm (0.25 in x 0.12 in). The right lower aspect of the tank was creased both horizontally and vertically over an 8.9 cm x 5.1 cm (3.5 in x 2.0 in) area. Located 15 cm (6 in) above the bottom edge of the tank was a 15 cm x 5 cm (6 in x 2 in) concave section from contact with the right exhaust. The center section of the tank was crushed to its full thickness, aft of the differential. The forward wall of the tank exhibited four indentations from the bolt heads of the differential cover. The indentations ranged from 6 mm to 13 mm (0.25 in to 0.5 in) in depth. A small hole, approximately 3 mm (0.12 in) in diameter, was located in an indentation 8.9 cm (3.5 in) above the tank's bottom edge. The residual dimension between the differential cover and deformed tank measured 4.6 cm (1.8 in). The forward left aspect of the tank was scuffed and dented over a broad area from contact with the left rear shock bracket, spring base and sway bar bracket. There were no perforations of the tank's left side. The retrofitted fuel lines, fuel filter, and sending unit were intact. There was no separation of the fuel filler neck from the tank.

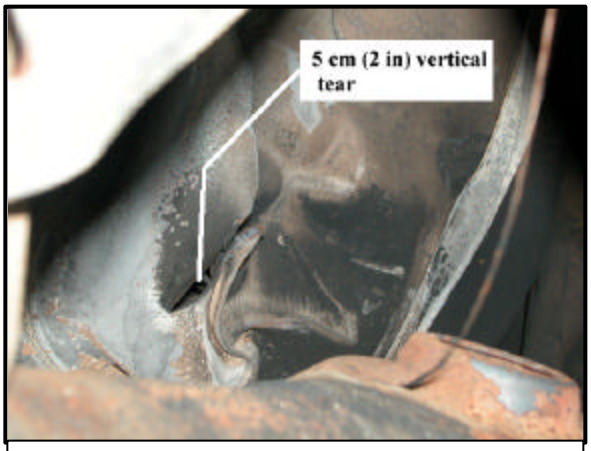

Figure 16: Tear and deformation of the lower right aspect of the tank.

The burn pattern observed on the vehicle indicated that the fire originated and was fueled from the right side of the fuel tank. The right side undercarriage components appeared scorched and heat stressed. These components were relatively free of soot and smoke as compared to the left. The center and left aspects of the fuel tank and undercarriage were coated with soot.

The procedure to grind the tabs on the sway bar bracket referenced in the Technical Safety Bulletin (TSB) issued by Ford on October 21, 2001 was not completed on this vehicle. However, it did not appear the sway bar brackets played a role in the tank failure. The shield kit developed by Ford Motor Company, in response to the Police Interceptor tank failures, was not installed on the vehicle.

1998 Ford F150 Pick-Up Truck

The 1998 Ford F150 pick-up truck, **Figure 17**, was identified by the Vehicle Identification Number (VIN): 1FTZX1761WN (production sequence deleted). The 454 kg (½ ton), 4x2, three-door extended cab pick-up was manufactured in September 1997 and was configured with a 353 cm (139 in) wheelbase. The power train consisted of a 3.6 liter/V8 engine linked to a 4-speed automatic transmission. The service brakes were front disc/rear drum with rear (2 channel) ABS. The pick-up was equipped with an aftermarket conversion by Sherrod Vans of Florida. The conversion consisted of a cap over the truck bed, custom running boards with fender flares, 51 cm (20 in) tires/wheels, custom leather seats (front and rear), wood trim instrument panel accents, door panel accents and an overhead console. The digital odometer could not be read.

Figure 17: Right view of the Ford F150.

Exterior Damage

The frontal plane of the Ford sustained 157.5 cm (62.0 in) of direct and induced damage as a result of the crash, **Figure 18**. The direct damage measured 128.0 cm (50.4) and began 51.0 cm (20.1 in) right of center extending to the left front corner. The crush profile measured along the front bumper was as follows: C1 = 57.0 cm (22.4 in), C2 = 35 cm (13.8 in), C3 = 46.0 cm (18.1 in), C4 = 47 cm (18.5 in), C5 = 20.0 cm (7.9 in), C6 = 11.0 cm (4.3 in). The maximum crush was located at C4. The frame rails had penetrated the front bumper during its deformation. The direct contact extended vertically across the center grille and radiator to the leading edge of the hood. Both front fenders shifted rearward and were overlapped by the front doors. The hood buckled and folded at the designated fold points. The left wheelbase was reduced 20.3 cm (8.0 in). The right wheelbase was unchanged. There was evidence of cab-to-bed contact on the left side and the bed cap was shifted rearward. The windshield was fractured directly forward of the driver's position from head contact. The Collision Deformation Classification (CDC) was 12-FDEW-3. The Delta V calculated by the Damage Algorithm of the WINSMASH model was 57.5 km/h (35.7 mph). The longitudinal and lateral components were -57.5 km/h (-35.7 mph) and 0, respectively.

Figure 18: Front view of the F150.

1997 Ford Escort Station Wagon

The 1997 Ford Escort Station wagon was identified by the Vehicle Identification Number (VIN): 3FALP15P9VR (production sequence deleted). The 4-door wagon was manufactured in January 1997 and the odometer had registered 258,357 km (160,540 miles). The vehicle was equipped with a 2.0 liter/I4 engine linked to a 4-speed automatic transmission and front disc/rear drum brakes (without ABS).

Exterior Damage

Figure 19 is the rear view of the damaged Escort. The vehicle sustained 149.4 cm (58.8 in) of induced and direct damage that extended across the end width of the rear plane as a result of the secondary collision with the Lincoln. The direct damage measured 112.8 cm (44.4 in) and began 37.6 cm (14.8 in) left of center extending to the right rear corner. The front bumper of the Lincoln engaged and deformed the rear bumper of the Escort and then partially overrode it, impacting the rear tailgate. The vehicle's crush profile was documented along the bumper reinforcement and along the rear edge of the tail gate. The averaged measured crush profile was as follows: C1 = 0, C2 = 2.0 cm (0.8 in), C3 = 6 cm (2.4 in), C4 = 21.0 cm (8.3 in), C5 = 14.0 cm (5.5 in), C6 = 19.0 cm (7.5 in).

Figure 19: Rear view of the Escort.

The tail gate latch released during the impact. The rear window glazing had disintegrated. All the doors were operational and the side window glazings were intact. There was no measurable change in wheelbase dimensions. The Collision Deformation Classification (CDC) was 06-BDEW-2. The Delta V calculated by the Damage Algorithm of the WINSMASH model was 22.0 km/h (13.6 mph).

OCCUPANT DATA

1998 Lincoln Town Car Limousine

Driver

The 42 year old driver (height and weight unknown) of the limousine sustained police reported C-type (possible) injuries. He exited the vehicle under his own power and was ambulatory at the scene. He was not able to render aid to the limousine occupants due to the developing post-crash fire

He was restrained at the time of the crash based on his police interview. Upon impact with the Ford F150, he exhibited a rearward trajectory in response to the 6 o'clock direction of force. The driver loaded the seat back with his torso, as the vehicle was accelerated forward. The inertial locking retractor locked in response to the impact. Upon frontal impact with the Ford Escort, the driver would have initiated a forward trajectory. He contacted the locked safety belt system with his torso and rode down the crash. He then rebounded back into his seat.

Limousine Occupants

The three female occupants of the limousine had reported ages of 29, 24 and 16 years. The height and weight of the occupants was not known. Information regarding the initial seat position and the manual restraint use of the occupants at the time of the crash was not known and could not be determined due to the circumstances of the fire. The Medical Examiner conducted autopsies of the occupants the day following the crash. The identified injuries for each occupant are listed in the tables below. The cause of death for each occupant was listed as thermal burn and smoke inhalation.

29 year old Female

Injury	***Injury Severity (AIS 98 update)***	***Injury Mechanism***
Extensive thermal injuries with charring, with skin splittage, extremity contraction and thermal fractures	Maximum 992032.6,0	Crash induced fire
Bilateral lung adhesion tears with hemothoraces, 50 ml right and 50 ml left	Severe 441450.4,3	Unrestrained contact to the limousine interior, component unknown
Soot present in airways, pulmonary congestion and edema, Carbon monoxide saturation 14 percent	Serious 919202.3,0	Crash induced fire
Focal subarchnoid hemorrhage, left frontal lobe	Serious 140684.3,2	Unrestrained contact to the limousine interior, component unknown
Splenic lacerations with 100 ml hemoperitoneum	Moderate 544222.2,2	Unrestrained contact to the limousine interior, component unknown

24 year old Female

Injury	***Injury Severity (AIS 98 update)***	***Injury Mechanism***
Extensive thermal injuries, near full body deep charring burns	Maximum 992032.6,0	Crash induced fire
Soot present in upper airways, Carbon monoxide saturation 16 percent	Serious 919202.3,0	Crash induced fire

16 year old Female

Injury	***Injury Severity (AIS 98 update)***	***Injury Mechanism***
Extensive thermal injuries with charring	Maximum 992032.6,0	Crash induced fire
Abundant sooty residues within air passages, pulmonary congestion and edema, Carbon monoxide saturation 21 percent	Severe 919204.4,0	Crash induced fire

Limousine Occupants Kinematics

The initial seat position of the occupants was unknown. Upon the rear impact from the Ford F150, the occupants would have exhibited a rearward trajectory in response to the 6 o'clock direction of the impact force. Any of the occupants seated on the forward-facing rear bench seat would have loaded the rear seat back with their torso. An occupant seated on the side-facing or the forward rear-facing seat would have been directed rearward. Given the severity of the impact force, the side/rear-facing occupants would have been displaced from their seated position. The blunt force chest injuries sustained by the 29 year old female probably occurred at this time.

Upon frontal impact with the Ford Escort, the occupants would have responded with a forward trajectory. The severity of the frontal impact was minor, as compared to the rear impact, and probably would not have caused the passengers to be displaced to a great extent.

Upon extinguishing the fire, the three occupants were found within the limousine interior. The 29 year old female was found on the left side of the forward rear-facing seat (aft of the driver's position), the 24 year old female was found on the floor with head resting on the forward rear-facing seat and the 16 year old female was found on the floor with her head near the rear forward-facing seat. It could not be determined if the occupants were displaced to these positions as a result of the crash forces or if the occupants migrated to these positions in an effort to escape the fire.

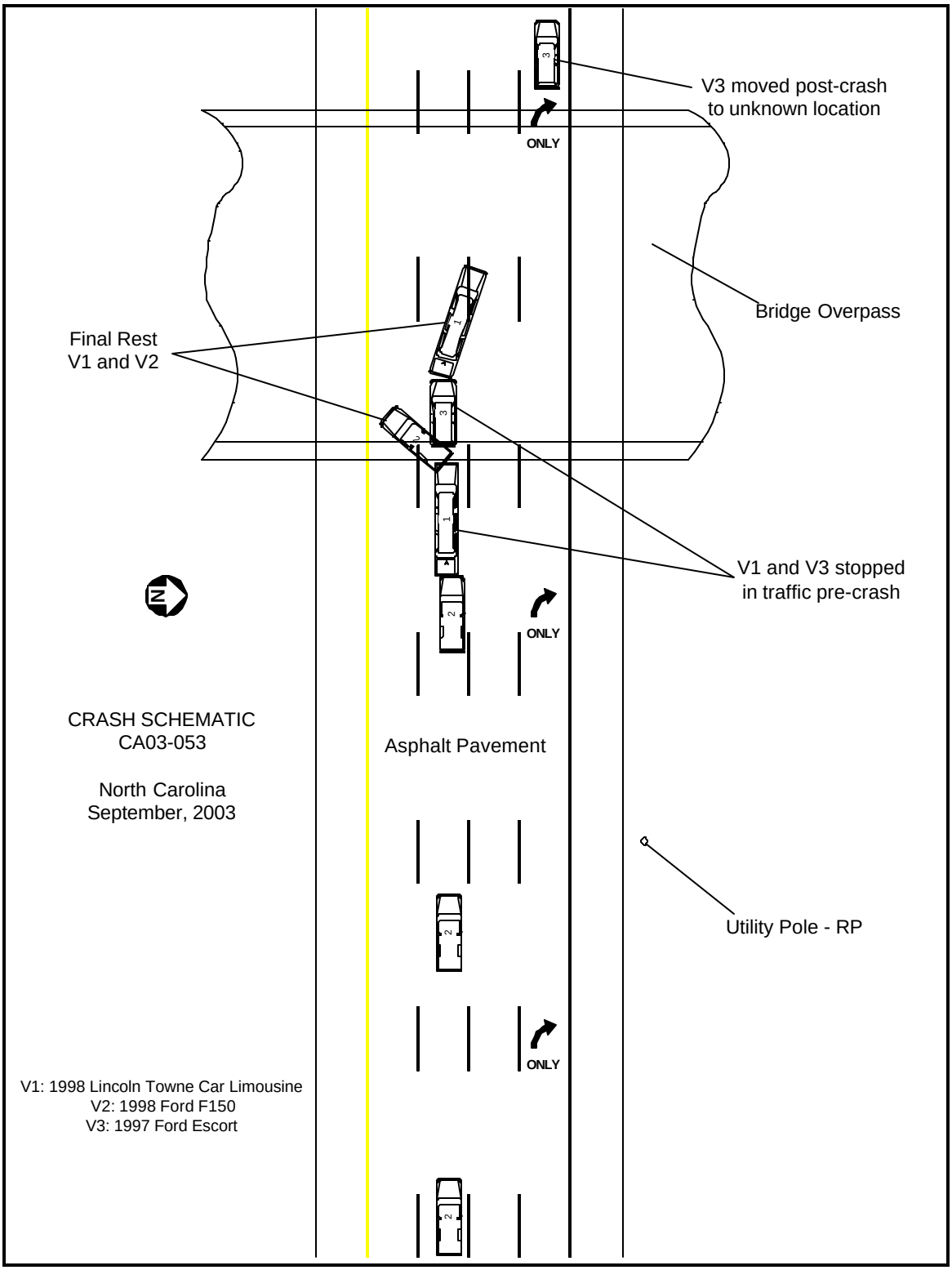

Figure 20: Crash schematic.