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GENERAL DYNAMICS REMOTE ADULT AIR BAG RELATED SERIOUS INJURY INVESTIGATION

CASE NO: CA03-010

VEHICLE: 1997 FORD F-150 PICKUP TRUCK

LOCATION: STATE OF GEORGIA

CRASH DATE: SEPTEMBER 1998

Contract No. DTNH22-01-C-17002

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.

TECHNICAL REPORT STANDARD TITLE PAGE

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16. Abstract This remote investigation effort focused on the severe injury mechanisms for a 50-year-old female front right passenger of a 1997 Ford F-150 pickup truck. The F-150 was also occupied by a 52-year-old male driver, a 6-year-old male rear left child passenger, and a 4-year-old rear right child passenger. Police reported all of the occupants as restrained, but restraint usage could not be confirmed by this remote investigation. The F-150 was involved in a frontal collision with a 1988 Lincoln Town Car that was making a left turn out of a driveway. The impact resulted in moderate frontal damage to the F-150 and was sufficient to deploy the frontal air bag system. The occupants initiated forward trajectories. The driver probably loaded the safety belt and contacted the deployed driver's air bag. Although the police reported that he sustained a serious injury, court documents stated that he did not sustain injury. The front right passenger most likely had the seat adjusted to a forward track position and was out-of-position forward. She was struck in the face by the expanding front right passenger's air bag and sustained a diffuse brain injury, multiple facial lacerations and contusions, a left eye contusion, a contusion to right superior chest, a left shoulder contusion and abrasion, and a distal left clavicle fracture. The air bag expansion displaced her right arm resulting in a right arm abrasion. Her right hand struck the windshield which resulted in a right hand abrasion. Her legs struck the glove box door which caused a right knee contusion, and contusions to the left and right lower legs. She was transported by ambulance to a regional trauma center and admitted for treatment. Due to her injuries, she was rendered fully incapacitated, unable to move or speak.			
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CRASH DATE: SEPTEMBER 1998

BACKGROUND

This remote investigative effort focused on the severe injury mechanisms for a 50-year-old female front right passenger of a 1997 Ford F-150 pickup truck. The F-150 was also occupied by a 52-year-old male driver, a 6-year-old male rear left child passenger, and a 4-year-old rear right child passenger. Police reported all of the occupants as restrained, but restraint usage could not be confirmed by this remote investigation. The F-150 **(Figure 1)** was involved in a frontal collision with a 1988 Lincoln Town Car that was making a left turn out of a driveway. The impact resulted in moderate frontal damage to the F-150 and was sufficient to deploy the frontal air bag system. The occupants initiated forward trajectories. The driver probably loaded the safety belt and contacted the deployed driver's air bag. Although the police reported that he sustained a serious injury, court documents stated that he did not sustain injury. The front right passenger most likely had the seat adjusted to a forward track position and was out-of-position forward. She was struck in the face by the expanding front right passenger's air bag and sustained a diffuse brain injury, multiple facial lacerations and contusions, a left eye contusion, a contusion to right superior chest, a left shoulder contusion and abrasion, and a distal left clavicle fracture. The air bag expansion displaced her right arm resulting in a right arm abrasion. Her right hand struck the windshield which resulted in a right hand abrasion. Her legs struck the glove box door which caused a right knee contusion, and contusions to the left and right lower legs. She was transported by ambulance to a regional trauma center and admitted for treatment. Due to her injuries, she was rendered fully incapacitated, unable to move or speak.

Figure 1. Overhead view of the damaged Ford F-150 pickup truck

This crash was identified from a daily news automotive website by the General Dynamics SCI team. The web article was forwarded to NHTSA's SCI headquarters and assigned to the General Dynamics SCI team as an on-site investigation, dependent upon the availability of the Ford F-150 pickup truck. The case was under litigation at the time of the assignment, and was settled in April 2003. The pickup truck was not available, and NHTSA modified the investigation as a remote effort. Photographs of the F-150 were obtained from the plaintiff's attorney, as well as copies of depositions that identified vehicle damage, crash sequence information, and injuries. This deposition data was acquired from reconstruction and medical professionals.

VEHICLE DATA – 1997 FORD F-150 PICKUP TRUCK

The 1997 Ford F-150 was identified by the Vehicle Identification Number (VIN): 1FTDX0868VK (production sequence omitted). The vehicle was a 3-door extended-cab pickup truck that was configured with a 2.0 m (6.5') long cargo box. The F-150 was equipped with a 4.6 liter, V-8 engine, an automatic four-speed transmission, front disc and rear drum power brakes with rear ABS, power steering, and a tilt steering wheel. It was reported in the court depositions that the vehicle's odometer read over 80,645 km (50,000 miles) at the time of the inspection. The F-150 was equipped with P265/70R17SL tires. The specific tire information was unknown, as there were no available photographs that displayed the outboard aspects of the tires on the vehicle. The manufacturer's recommended tire pressure was 200 kpa (29 psi) and for the front tires and 221 kpa (32 psi) for the rear tires.

The seating in the Ford F-150 was configured with front bucket seats and a rear bench seat with a folding back. The driver's seat track position was unknown. The front right seat track position was described as "six free slots in front of the device that clasps the seat tracks," and "the top slider was 3.8 cm (1.5") forward of the lower slider, which placed the seat in the forward quarter of the total track travel." The forward edge of the seat was reported to have measured 22.2 cm (8.8") from the glove box door. It should be noted that there was some discrepancy as to whether the seat track was adjusted post-crash. The front right passenger was positioned in an exemplar vehicle during the litigation proceedings and the following approximate measurements were reported:

Measurement	Magnitude
Knees to instrument panel	3.8 cm (1.5")
Left chest to air bag cover flap centerline	54.0 cm (21.3")
C-7 (cervical spine) to front right seat back	10.2 cm (4.0")
Forehead to air bag cover flap centerline	61.6 cm (24.3")
Nose to base of the windshield	91.4 cm (36.0")

VEHICLE DATA – 1988 LINCOLN TOWN CAR

The 1988 Lincoln Town Car was identified by the VIN: 1LNBM81F4JY (production sequence omitted). The vehicle was a four-door sedan equipped with a 5.0 liter, V-8 engine, an automatic transmission, and power steering. There were no available photographs of the vehicle and the specific tire information was unknown.

CRASH SITE

This two-vehicle crash occurred during the daylight hours of September 1998 in the state of Georgia. At the time of the crash, the weather was clear and the asphalt roadway surface was dry. The crash occurred on a two lane, north/south roadway that was configured with one travel lane in each direction, separated by a broken yellow centerline. The roadway was straight at the scene of the crash, and the PAR indicated a positive grade, but did not specify the grade direction.

Police reported the width of the roadway to be 7.3 m (24.0'). The roadway was bordered by white fog lines and roadside ditches. The width and depth of the ditches was not specified, however, the centerline of the west ditch was located 4.3 m (14.0') outboard of the west fog line. The roadside environment included private driveways and residential areas. The posted speed limit was 89 km/h (55 mph). The police scene schematic is included as **Figure 9** at the end of this report.

CRASH SEQUENCE

Pre-Crash

The 52-year-old male driver was operating the Ford F-150 pickup truck in a northbound direction on the two-lane roadway. A non-contact vehicle initiated a left turn across the path of the F-150 from a driveway located on the east side of the roadway. As the F-150 approached the driveway, the 74-year-old male driver of the Lincoln Town Car, following the non-contact vehicle, initiated a left turn across the path of the F-150. According to court depositions, the Lincoln Town Car did not stop, hesitate, or attempt any avoidance maneuvers as it entered the roadway with the intent to travel south. The driver of the F-150 applied the brakes in an attempt to avoid the collision. Based on the expert depositions, it was suggested that the driver of the F-150 may have attempted to steer left prior to the crash.

Crash

The front right and front center aspects of the F-150 impacted the left front aspect of the Lincoln Town Car. Impact resulted in moderate damage to both vehicles and was sufficient to deploy the frontal air bag system in the F-150. The plaintiff's expert reconstructionist estimated a delta-V between 10 and 13 km/h (6 and 8 mph) for the Ford F-150, which appeared low based on the damage to the front bumper. The defense attorney's expert reconstructionist estimated a total delta-V of 18 km/h (11 mph) for the F-150. The damage algorithm of the WinSMASH program computed a total delta-V of 17.0 km/h (10.6 mph) and a barrier equivalent speed of 16.8 km/h (10.5 mph) based on an estimated frontal crush profile. The WinSMASH results appeared reasonable given the frontal damage. An estimated delta-V for the Town Car was not included in the available case information. The impact induced a clockwise (CW) rotation of the Town Car. The final rest positions of the vehicles were not documented, and could not be confirmed. It was stated that the Town Car came to rest at angle, relative to the roadway with the front wheels in the northbound lane and the rear wheels in the southbound lane. The pickup truck came to rest facing northwest, the front wheels in the west roadside ditch and the rear wheels on the shoulder of the roadway.

Post-Crash

The front right passenger of the Ford F-150 was removed from the vehicle by rescue personnel. The remaining occupants were reported to have not been injured, and it was not known how they exited the vehicle. The front right passenger was transported to a local hospital and admitted for treatment.

VEHICLE DAMAGE

Exterior Damage – 1997 Ford F-150 Pickup Truck

The exterior damage to the 1997 Ford F-150 was based on photographs obtained from the plaintiff's attorneys. The pickup truck sustained moderate frontal damage **(Figures 2 and 3)** as a result of the impact with the Lincoln Town Car. The direct contact damage began at the front right bumper corner and extended 162 cm (64") laterally across the bumper to the front left corner. Paint transfers were present across the entire width of the bumper from contact with the Town Car. The maximum crush at the front bumper was reported as 22.6 cm (8.9") and was located approximately 8 cm (3") to the right of the vehicle's centerline. The damage to the center aspect of the F-150's bumper appeared to be a result of direct engagement with the left front corner of the Town Car's bumper. Scuff marks and paint transfers were present on the upper aspect of the bumper and the lower aspect of the grille and headlamps. The vertical height of the damage did not extend above the lower aspect of the grille. The combined direct and induced damage involved the entire frontal width of the vehicle. The left front fender was buckled slightly rearward and the front aspect of the left frame rail was deflected slightly to the right. The plastic license plate frame was partially separated. The Collision Deformation Classification (CDC) for the frontal impact with the Lincoln Town Car was 12-FDEW-1. Six crush measurements were estimated along the front bumper of the Ford F-150 and were as follows: C1 = 0.0 cm, C2 = 3.8 cm (1.5"), C3 = 15.2 cm (6.0"), C4 = 20.3 cm (8.0"), C5 = 3.8 cm (1.5"), C6 = 0.0 cm.

Figure 2. Frontal view of damaged F-150 pickup truck

Figure 3. Undercarriage view of damaged Ford F-150

Interior Damage – 1997 Ford F-150 Pickup Truck

Interior damage to the F-150 was minor and attributed to occupant contact. The windshield sustained a focused fracture on the top right aspect **(Figure 4)** from probable contact with the front right passenger's hand. The entire right side of the windshield sustained a broad fracture from the compression of the front right passenger's air bag against the windshield.

Figure 4. View of fractured windshield

The top half of the steering wheel rim was deformed forward. There was no visible damage to the plastic knee bolster or left instrument panel. The glove box door was open post-crash **(Figure 5)** and it was stated that the latch was damaged as a result of occupant loading. There was no visible damage or deformation to the face of the glove box door in the photographs. There were no intrusions into the passenger compartment.

Figure 5. Interior view from right side

Exterior Damage – 1988 Lincoln Town Car

The 1988 Lincoln Town Car sustained police-reported moderate left front damage. There were no available photographs of the damaged Town Car.

MANUAL RESTRAINT SYSTEMS – 1997 FORD F-150 PICKUP TRUCK

Due to the remote nature of this investigation, restraint use by the occupants could not be confirmed. The driver's safety belt was configured with a sliding latch plate, a fixed D-ring, and an Emergency Locking Retractor (ELR). The front right passenger's safety belt was configured with a sliding latch plate and a switchable ELR/Automatic Locking Retractor (ALR). Due to the presence of the right side rear door, the front right passenger's fixed D-ring was suspended from a plastic sleeve that was mounted to the right roof side rail behind the seat back. There were no available photographs of the safety belt webbing to evaluate loading evidence. Some faint linear striations were present on the front right passenger's D-ring, but it could not be determined if they were crash-related or a result of historical use.

The rear outboard safety belts were configured with sliding latch plates, fixed D-rings, and switchable ELR/ALR retractors. The rear center position was configured with a 2-point lap belt with a locking latch plate.

FRONTAL AIR BAG SYSTEM - 1997 FORD F-150 PICKUP TRUCK

The Ford F-150 was equipped with frontal air bags **(Figure 6)** for the driver and front right passenger positions that deployed as a result of the frontal impact. The driver's air bag deployed from the center of the steering wheel hub through a single cover flap hinged at the top aspect. The driver's air bag was folded and partially exposed from the module in the photographs. There were no available photographs that displayed the entire face of the deployed driver's air bag.

Figure 6. View of frontal air bag system through driver's door

The front right passenger's air bag deployed from a mid-mount module with a single cover flap design. The cover flap was rectangular in shape and was hinged at the top/forward aspect (relative to the vehicle). The cover flap was distorted/twisted **(Figure 7)** from probable occupant contact with the front right passenger's right arm. The air bag was designed with an additional chamber on the left aspect which allowed the bag to extend laterally across both the right and center seating positions. The wide air bag **(Figure 8)** was designed with the intent to provide protection to a potential occupant seated in the center position, if the vehicle had been equipped with a bench seat. A vertical seam was present on the air bag fabric which separated the main chamber from the additional chamber. There were no vent ports visible in the photographs and it was stated in court documents that the air bag fabric was porous to allow a certain amount of venting, in addition to venting back through the air bag module.

A possible makeup transfer from the front right passenger was present near the center of the air bag face. Post-crash transfers of body fluid (blood) were also present on the air bag fabric.

Figure 7. View of front right passenger's air bag cover flap

Figure 8. Partial view of the face of the front right passenger's air bag

OCCUPANT DEMOGRAPHICS – 1997 FORD F-150 PICKUP TRUCK

Driver

Age/Sex:	52-year-old male
Height:	Not reported
Weight:	Approximately 109 kg (240 lb)
Seat Track Position:	Not reported
Manual Restraint Use:	Manual 3-point lap and shoulder belt
Usage Source:	Lack of serious injury, police report
Eyewear:	Unknown
Type of Medical Treatment:	Did not sustain injury and did not receive medical treatment

Driver Kinematics

The 52-year-old male driver was presumed to have been seated in an upright posture. Although safety belt usage could not be confirmed, he was probably restrained, given his lack of injury. When he detected the Lincoln Town Car traveling across the lane, he applied the brakes and braced his arms against the steering wheel rim, evidenced by the forward deflection of the top of the rim. At impact, the frontal air bag system deployed and the driver initiated a forward trajectory. He loaded the manual restraint and the deployed driver's air bag which mitigated additional contact with the steering wheel. He rebounded rearward and came to rest in the driver's seat. He did not sustain injury and did not receive medical treatment.

Front Right Passenger

Age/Sex:	50-year-old female
Height:	152 cm (65”)
Weight:	62 kg (137 lb)
Seat Track Position:	Between the full-forward and mid-track positions
Manual Restraint Use:	Unknown
Usage Source:	Injury data, court documents
Eyewear:	Unknown
Type of Medical Treatment:	Transported by ambulance to a regional trauma center and admitted for treatment

Front Right Passenger Injuries

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Obliteration of the cisterns and focal lesion in the right basal ganglia with extensive hemorrhage in the pons and swelling of the pons	Critical (140210.5,8)	Indirect: Expansion of the front right passenger’s air bag, possible hyperextension of the neck
Temporal subarachnoid hemorrhage (right and left sides of brain)	Serious (140684.3,1) Serious (140684.3,2)	Expanding front right passenger’s air bag
Distal left clavicle fracture	Moderate (752200.2,2)	Expanding front right passenger’s air bag
Left temporal abrasion	Minor (290202.1,2)	Expanding front right passenger’s air bag
Multiple facial contusions	Minor (290402.1,0)	Expanding front right passenger’s air bag
Left eye contusion	Minor (290402.1,2)	Expanding front right passenger’s air bag
Multiple minor facial lacerations	Minor (290602.1,0)	Expanding front right passenger’s air bag
Contusion to right superior chest	Minor (490402.1,1)	Expanding front right passenger’s air bag
Right forearm abrasion	Minor (790202.1,1)	Expanding front right passenger’s air bag
Right hand abrasion	Minor (790202.1,1)	Windshield
Left shoulder abrasion	Minor (790202.1,2)	Expanding front right passenger’s air bag
Left shoulder contusion	Minor (790402.1,2)	Expanding front right passenger’s air bag
Contusion to right knee and right lower leg	Minor (890402.1,1)	Glove box door

Injury	Injury Severity (AIS 90/Update 98)	Injury Mechanism
Contusion to left lower leg	Minor (890402.1,2)	Glove box door

Injury source: Court documents (from medical records)

Front Right Passenger Kinematics

The 50-year-old female front right passenger was out-of-position forward at the time of the crash, presumably as a result of pre-crash braking. The seat track was adjusted between the mid-track and full-forward positions, and it was not known if she was utilizing the manual 3-point lap and shoulder belt. She probably extended her arms in an effort to brace against the upper instrument panel and the front right passenger's air bag module cover flap. At impact, the frontal air bag system deployed and the cover flap probably struck her right arm. She initiated a forward trajectory. The expansion of the air bag displaced her right arm vertically based on the abrasion to her right arm. The right arm displacement caused her right hand to strike the windshield which resulted in an abrasion to her right hand, and was evidenced by the focused contact to the windshield. There was no soft tissue injury to support air bag expansion under the chin or anterior neck. Her knees struck the glove box door, evidenced by the damage to the glove box door latch. The contact with the glove box door resulted in a contusion to the right knee, a contusion to the right lower leg, and a contusion to the left lower leg. The expanding air bag struck her in the face which resulted in multiple minor facial lacerations, multiple facial contusions, a left eye contusion, a left temporal abrasion, and a temporal subarachnoid hemorrhage. The interaction with the deploying air bag caused the rearward acceleration of her head and a probable hyperextension of her neck which resulted in the obliteration of the cisterns and focal lesion in the right basal ganglia with extensive hemorrhage in the pons and swelling of the pons. The air bag also struck her upper torso which produced a contusion to right superior chest, a left shoulder contusion, a left shoulder abrasion, and a distal left clavicle fracture. She rebounded rearward against the front right seat back and came to rest in the seat. She was transported by ambulance to a regional trauma center and admitted for treatment.

Rear Left Passenger

Age/Sex:	6-year-old male
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Fixed
Manual Restraint Use:	Unknown (police reported manual 3-point lap and shoulder belt)
Usage Source:	Police report
Eyewear:	Unknown
Type of Medical Treatment:	Did not sustain injury and did not receive medical treatment

Rear Left Passenger Kinematics

The 6-year-old male child was seated on the left position of the rear bench seat. It was unknown if the child was restrained by the available manual 3-point lap and shoulder belt, although police reported safety belt use. At impact, he initiated a forward trajectory. If the child were restrained, he would have loaded the safety belt and remained in position. If the child was not restrained, he would have struck the rear aspect of the driver's seat back and rebounded rearward. Although the police report stated that the child sustained a visible injury, court documents stated the he was uninjured and did not receive medical treatment.

Rear Right Passenger

Age/Sex:	4-year-old female
Height:	Unknown
Weight:	Unknown
Seat Track Position:	Fixed
Manual Restraint Use:	Unknown (police reported manual 3-point lap and shoulder belt)
Usage Source:	Police report
Eyewear:	Unknown
Type of Medical Treatment:	Did not sustain injury and did not receive medical treatment

Rear Right Passenger Kinematics

The 4-year-old female child was seated on the right position of the rear bench seat. It was unknown if the child was restrained by the available manual 3-point lap and shoulder belt, although police reported safety belt use. At impact, she initiated a forward trajectory. If the child were restrained, she would have loaded the safety belt and remained in position. If the child was not restrained, she would have struck the rear aspect of the front right seat back and rebounded rearward. She did not sustain injury and did not receive medical treatment.

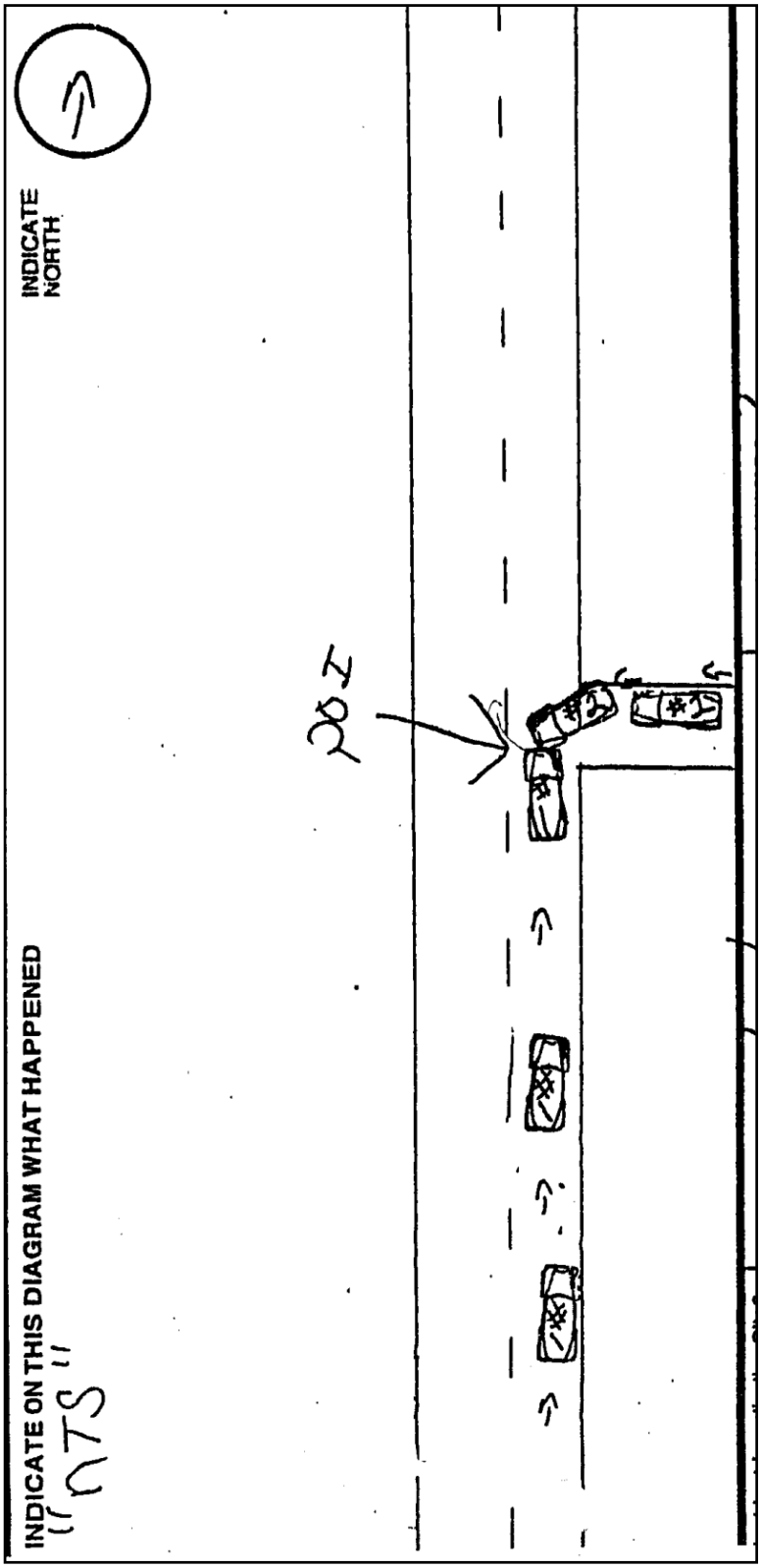

Figure 9. Police scene schematic