CRASH DATA RESEARCH CENTER

Calspan Corporation
Buffalo, NY 14225

CALSPAN ON-SITE CHILD AIR BAG RELATED FATALITY CRASH INVESTIGATION

CASE NO: CA05-048

VEHICLE: 1996 FORD CONTOUR GL

LOCATION: MISSISSIPPI

CRASH DATE: AUGUST 2005

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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. CA05-048	*2. Government Accession No.*	*3. Recipient's Catalog No.*	
4. Title and Subtitle Calspan On-Site Child Air Bag Related Fatality Crash Investigation Vehicle: 1996 Ford Contour GL Location: State of Mississippi		*5. Report Date*: June 2006 *6. Performing Organization Code*	
7. Author(s) Crash Data Research Center		*8. Performing Organization Report No.*	
9. Performing Organization Name and Address Crash Data Research Center Calspan Corporation P.O. Box 400 Buffalo, New York 14225		*10. Work Unit No.* C00410.0000.0313 *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: August 2005 *14. Sponsoring Agency Code*	
15. Supplementary Note This on-site investigation focused on the severity of the crash and the injury source that contributed to the death of an unrestrained 6-year-old female child seated in the front right position of a 1996 Ford Contour.			
16. Abstract This on-site investigation focused on the severity of the crash and the injury source that contributed to the death of an unrestrained 6-year-old female child seated in the front right position of a 1996 Ford Contour. The Ford Contour was equipped with first generation frontal air bags for the driver and front right positions that deployed as a result of a minor severity front-to-rear crash with a 1991 Cadillac Sedan DeVille. The Contour was also occupied by a 38-year old female driver, a 14-year old female seated in the rear right, and a 7-month old child held on the lap of the rear right passenger. The driver of the Contour was traveling southbound behind the DeVille, which stopped prior to a T-intersection for a non-contact vehicle that was turning left at the intersecting roadway. The driver of the Contour braked in an attempt to avoid the impact. The unrestrained 6-year old child passenger, who was reportedly kneeling on the front right seat, was displaced forward by the pre-crash braking. The front right area of the Contour struck the back left area of the Cadillac resulting in minor damage to the Contour. The deceleration forces were sufficient to deploy the vehicle's frontal air bag system. The 6-year-old child was struck under the chin by the front right air bag module cover flap. The flap contact and subsequent air bag expansion accelerated her vertically into the windshield. The continued expansion of the air bag propelled her rearward into the windshield header and the headliner, evidenced by strands of hair. Based on the low delta-V of this crash and the child's interaction with the cover flap and expanding air bag, the cover flap was determined to be the source of the cervical spine injury. The child passenger came to rest on the rear left aspect of the rear seat with her lower extremities positioned between the front seats. The child was removed from the vehicle by the driver and was placed on the ground adjacent to the crash site. She expired at the scene due to injuries related to a cervical spine fracture identified by the Coroner. No autopsy was performed and no further injury information was available. The other three occupants of the Contour were not injured.			
17. Key Words Air bag related child fatality Child seated in front right position		*18. Distribution Statement* General Public	
19. Security Classif. (of this report) Unclassified	*20. Security Classif. (of this page)* Unclassified	*21. No. of Pages* 11	*22. Price*

TABLE OF CONTENTS

CALSPAN ON-SITE CHILD AIR BAG RELATED FATALITY CRASH INVESTIGATION
CASE NUMBER: CA05-048
VEHICLE: 1996 FORD CONTOUR GL
LOCATION: MISSISSIPPI
CRASH DATE: AUGUST 2005

BACKGROUND

This on-site investigation focused on the severity of the crash and the injury source that contributed to the death of an unrestrained 6-year-old female child seated in the front right position of a 1996 Ford Contour. The Ford Contour **(Figure 1)** was equipped with first generation frontal air bags for the driver and front right positions that deployed as a result of a minor severity front-to-rear crash with a 1991 Cadillac Sedan DeVille. The Contour was also occupied by a 38-year old female driver, a 14-year old female seated in the rear right, and a 7-month old child held on the lap of the rear right passenger. The driver of the Contour was traveling southbound behind the DeVille, which stopped prior to a T-intersection for a non-contact vehicle that was turning left at the intersecting roadway. The driver of the Contour braked in an attempt to avoid the impact. The unrestrained 6-year old child passenger, who was reportedly kneeling on the front right seat, was displaced forward by the pre-crash braking. The front right area of the Contour struck the back left area of the Cadillac resulting in minor damage to the Contour. The deceleration forces were sufficient to deploy the vehicle's frontal air bag system. The 6-year-old child was struck under the chin by the front right air bag module cover flap. The flap contact and subsequent air bag expansion accelerated her vertically into the windshield. The continued expansion of the air bag propelled her rearward into the windshield header and the headliner, evidenced by strands of hair. Based on the low delta-V of this crash and the child's interaction with the cover flap and expanding air bag, the cover flap was determined to be the source of the cervical spine injury. The child passenger came to rest on the rear left aspect of the rear seat with her lower extremities positioned between the front seats. The child was removed from the vehicle by the driver and was placed on the ground adjacent to the crash site. She expired at the scene due to injuries related to a cervical spine fracture identified by the Coroner. No autopsy was performed and no further injury information was available. The other three occupants of the Contour were not injured.

Figure 1- Damaged 1996 Ford Contour

This crash was reported to NHTSA through an Internet news article. The article was forwarded to the Calspan Special Crash Investigations (SCI) team on August 11, 2005 for investigative follow-up. Initially the police reported the crash as a non-deployment event; however, telephone follow-up with the investigating officer revealed the

deployment of the frontal air bag system and the minor severity of the crash. Due to the police estimated crash severity, the air bag deployment, the death of the child passenger, and the non-injured status of the other occupants, this crash was assigned for an on-site investigation. The vehicle was impounded by the police agency and cooperation was established for an SCI inspection, which was completed on August 15, 2005. The Cadillac DeVille was inspected on August 16, 2005.

SUMMARY

Crash Site

This two-vehicle crash occurred during daylight hours in the state of Mississippi in August 2005. The crash was intersection related, having occurred 13 m (43') north of a three-leg T-intersection. At the time of the crash, there were no adverse weather conditions and the roadway was dry. The crash occurred on a two-lane, north/south asphalt roadway bordered by paved shoulders and exhibited a slight positive grade in the southbound direction. The roadway was delineated by a double yellow centerline with solid white edge lines. There were no traffic controls for the north/southbound traffic flow. The posted speed limit was 56 km/h (35 mph). A shallow drainage ditch was present on the westbound roadside located 0.8 meters (2.6') outboard of the paved shoulder. The scene schematic is included as **Figure 11** at the end of this narrative report.

Vehicle Data – 1996 Ford Contour

The subject vehicle in this crash was a 1996 Ford Contour GL that was manufactured in December 1995 and identified by the Vehicle Identification Number (VIN) 3FALP6534TM (production sequence omitted). The vehicle was a four-door sedan, equipped with a 2.0 liter, 4-cylinder engine linked to a 3-speed automatic transmission with front wheel drive. The service brakes were power-assisted front disc/rear drum brakes. At the time of the vehicle inspection, the odometer read 177,285 km (110,163 miles). The manufacturer recommended tire pressures were 234 kPa (34 PSI) for both axles. The Contour was equipped with OEM steel wheel and all season radial tires. The specific tire information at the time of the SCI inspection was as follows:

Position	Tire Type/Size	Measured Pressure	Measured Tread Depth	Damage
LF	Hankook Radial H-714 - P185/70R14	223 kPa (33 PSI)	6 mm (8/32")	None
LR	Hankook Radial H-714 - P185/70R14	220 kPa (32 PSI)	7 mm (9/32")	None
RF	Hankook Radial H-714 - P185/70R14	210 kPa (31 PSI)	6 mm (7/32")	None
RR	Hankook Radial H-714 - P185/70R14	217 kPa (32 PSI)	6 mm (8/32")	None

The interior of the 1996 Ford Contour was configured with a fixed center console and front bucket seats with adjustable head restraints for the driver and front right positions. The front left head restraint was in a full down position while the front-right head restraint was adjusted 3 cm (1") above the seat back. The front left seat track was

adjusted to 4 cm (1.4”) forward of full rear and 17 cm (6.8”) rear of full forward. The front right seat track was adjusted to 8 cm (3.0”) forward of full rear and 13 cm (5.1”) rear of full forward. The rear seat was a three-passenger bench seat with a fixed seat back. The rear seat positions were not equipped with head restraints.

1991 Cadillac Sedan DeVille

The struck 1991 Cadillac Deville was identified by VIN 1G6CD53B2M4 (production number deleted). The vehicle was four-door sedan that was powered by a 4.9 liter V-8 engine with a four-speed automatic transmission. At the time of the SCI inspection, the DeVille’s odometer read 241,125 km (149,832 miles). The Cadillac was initially towed from the scene of the crash to a police impound. The vehicle was released to the owner and was inspected in its damaged state at the owner’s residence.

Crash Sequence

Pre-Crash

The 38-year old female driver of the Contour was operating the vehicle in a southbound direction on the two-lane roadway (**Figure 2**). Her pre-impact speed was unknown, but was below the speed limit according to a witness. A 54-year old female driver of the Cadillac was operating the vehicle in a southbound direction, traveling ahead of the Contour. Both vehicles were approaching a T-intersection. The driver of the Cadillac slowed to a stop approximately 13 meters (43 ft) north of the intersection behind a non-contact vehicle that was waiting to initiate a left turn onto the intersecting roadway. The driver of the Contour failed to detect the Cadillac in sufficient time as she braked in an attempt to avoid the impending crash. The driver of a non-contact sport utility vehicle that was following the Contour steered right onto the shoulder and roadside to avoid possible impact with the Contour. There was no pre-crash physical evidence at the scene.

Figure 2 - Southbound approach for both vehicles

Figure 3 – Impact and final rest positions for both vehicles

Crash

The front right area of the Ford Contour struck the back left aspect of the Cadillac DeVille in the southbound travel lane (**Figure 3**). The resultant directions of force were 12 o’clock for the Contour and 6 o’clock for the struck Cadillac. The impact resulted in minor residual crush to the rear bumper of the Cadillac. The Contour did not sustain

residual damage to the frontal structure. The damage was limited to abrasions and paint transfers to the bumper fascia and an isolated area of roof deformation above the right B-pillar. The damage algorithm of the WinSMASH program computed a total delta-V of 15.0 km/h (9.3 mph) for the Contour and 12.0 km/h (7.5 mph) for the Cadillac, based on crush analysis of both vehicles. The longitudinal and lateral components of the delta Vs were -15 km/h (-9.3 mph) and 0 km/h for the Contour and 12 km/h (7.5 mph) and 0 km/h for the struck Cadillac. The impact resulted in a sufficient longitudinal deceleration to deploy the frontal driver and passenger air bags in the Contour. Both vehicles came to final rest forward of the point of impact.

Post-Crash

The Ford Contour and Cadillac DeVille came to rest engaged in the southbound travel lane. Final rest positions were documented by the investigating police officer and marked on the asphalt road surface. The 38-year old female driver and 14-year old female passenger exited the Contour under their own power and through the front left and the right rear doors, respectively. The 14-year old passenger removed the 7-month old from the vehicle. The driver opened the left rear door and removed the 6-year old child from the rear seat of the vehicle and placed her on the grassy roadside. Professional firefighters and paramedics responded to the scene. Attempts to revive the 6-year-old child were unsuccessful and she expired at the scene. Although the Contour was drivable following the crash, it was impounded by the police and towed to a secure facility where it was held for this SCI investigation. The Cadillac was drivable post-crash; however, it was also impounded before being returned to its owner a few days following the crash.

Vehicle Damage

Exterior Damage – 1996 Ford Contour

The 1996 Ford Contour (**Figure 4**) sustained no structural damage as a result of the frontal impact with the 1991 Cadillac Sedan DeVille. The direct contact damage on the front bumper fascia began 3 cm (1.1”) left of the centerline and extended 72 cm (28.4”) to the right, ending 5 cm (1.9”) inboard of the front right corner. No measurable frontal crush was identified. The front right turn signal lens was fractured. The bumper fascia, grille, headlamp assembly, front fenders, and hood remained in alignment post-crash (**Figure 5**). No crush measurements were taken due to the absence of crush on the frontal plane. An isolated dent (induced buckling) was present 10 cm (4”) rear of the right B-pillar on the roof, and 10 cm (4”) inboard of the right roof side rail. The Collision Deformation Classification (CDC) for this impact event was 12-FZEW-1.

Figure 4 –Front right direct contact damage to the 1996 Ford Contour.

Figure 5 - Overhead view documenting the lack of frontal crush.

Interior Damage – 1996 Ford Contour

The interior of the Ford Contour sustained minor severity damage that resulted from the air bag deployment and contact from the front right child passenger (**Figure 6**). There was no passenger compartment intrusion in the Contour. The deploying front right passenger air bag displaced the child passenger vertically into the windshield. Her head impacted and fractured the windshield directly above the front right air bag module. Strands of hair were embedded in the glass. The hair transfers began 28 cm (11") right of the vehicle centerline and extended 13 cm (5") to the right. Vertically, the hair transfers began 4 cm (1.5") below the windshield header and extended 33 cm (13") in length. Hair strands continued onto the right sun visor and headliner of the vehicle as the front right passenger was propelled rearward by the expanding air bag. The hair pattern along the headliner crossed the visor and continued 74 cm (29") rearward. The hair transfers were 13 cm (5") in width and were located 28 – 41 cm (11-16") right of the vehicle's centerline and extended rearward deflecting to the left, ending 10-23 cm (4-9") right of the centerline. The front right air bag module cover flap was deformed by contact with the child passenger. This damage is addressed in the section entitled, "Frontal Air Bag System."

Figure 6 – Child passenger contact evidence on windshield, header, sun visor, and headliner.

Exterior Damage – 1991 Cadillac DeVille

The 1991 Cadillac DeVille sustained minor rear left damage as a result of the impact with the 1996 Ford Contour (**Figure 7**). The direct contact damage began 21 cm (8.3") left of the centerline and extended 60 cm (23.8") to the left. Maximum crush was 10 cm (4.1") located at the left rear bumper corner. The rear left quarter panel sustained minor induced buckling. Six crush measurements were documented across the rear bumper as follows: C1 = 10 cm (4.1"), C2 = 8 cm (3"), C3 = 6.4 cm (3"), C4 = 5 cm (1.5"), C5 = 0 cm, C6 = 0 cm. The Collision Deformation Classification (CDC) for this impact was 06-BYEW-1.

Figure 7 – Back left damage to the Cadillac DeVille.

Manual Safety Belt Systems – 1995 Ford Contour

The 1995 Ford Contour was equipped with a manual 3-point lap and shoulder belts for all four outboard seating positions and a 2-point lap belt with a locking latch plate for the rear center position. The driver's position was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). The driver in this crash did not wear the safety

belt. At the time of the vehicle inspection, the driver's safety belt was found in a stowed position and was fully operational. There was historical wear marks present on the latch plate, as well as rippling in the belt; however, there was no loading evidence.

The front right safety belt system was configured with a sliding latch plate and an Emergency Locking Retractor (ELR). A fold was present in the webbing at the D-ring and there was minor historical wear marks on the latch plate and webbing; however, there was no loading evidence consistent with the crash and child passenger kinematics. The front right passenger was not wearing the lap and shoulder belt during the crash sequence.

The second row was equipped with continuous loop webbings, sliding latch plates, and ELR retractors in both outboard positions. The right rear belt had subtle wear patterns but no evidence of crash related loading.

Frontal Air Bag System – 1996 Ford Contour

The 1996 Ford Contour was equipped with frontal air bags for the driver and front right passenger positions. The driver's air bag deployed through asymmetrical H-configuration module cover flaps. The upper flap measured 19 cm (7.5") in width at the horizontal tear seam and 9 cm (3.5") in height. The lower flap measured 19 cm (7.5") in width and 8 cm (3") in height. The driver's air bag (**Figure 8**) measured 56 cm (22") in diameter in its deflated state. Two circular ports that measured 2 cm (0.8") in diameter vented the air bag. The vent ports were spaced on 15 cm (6.0") centers, and located 6 cm (2.5") inboard of the peripheral seam. Four internal straps tethered the bag at the 12, 3, 6, and 9 o'clock positions. The tether stitching on the face of the driver's air bag was 17 cm (6.8") in diameter. There was no discernable contact evidence on the driver's air bag or cover flap.

Figure 8 – Deployed driver's air bag

The front right passenger's air bag (**Figure 9**) deployed through a top-mount module with a rectangular cover flap hinged at the forward aspect. The cover flap measured 33 (13") in width and 19 cm (7.5") in height. The top aspect of the cover flap was contoured to the curvature of the top aspect of the instrument panel. At the time of deployment, the front right passenger's head was positioned above the rectangular cover flap. The flap contacted the anterior surface of the child passenger's chin, deforming the steel reinforced flap to a U-shaped pattern (**Figure 10)**. The interaction between the child and the cover flap resulted in an 8 cm (3.1") deflection of the cover flap. Although the cover flap was

Figure 9 - Front right air bag

severely deformed by contact with the child passenger, there were no tissue or fabric transfers on the face or leading edge of the cover flap.

The front right passenger's air bag measured 70 cm (27.5") in width and 47 cm (18.5") in height. The air bag was vented internally and was not tethered. A tissue transfer was present on the upper right quadrant of the air bag. The transfer began at the top surface of the bag and extended 11 cm (4.5") downward and was centered on the vertical centerline. Several loose strands of hair were noted to the top aspect on the passenger's air bag.

Occupant Demographics/Data

Driver – 1996 Ford Contour

Age/Sex:	38-year-old/Female
Height:	173 cm (68")
Weight:	70 kg (155 lb)
Seat Track Position:	Rear track position, adjusted 3.6 cm (1.4") forward of full rear and 17.3 cm (6.8") rear of full forward
Manual Restraint Use:	None Used
Usage Source:	Vehicle Inspection
Eyewear:	Not available
Type of Medical Treatment:	None

Driver Kinematics

The driver of the 1996 Ford Contour was seated in a rear track position with the seat back adjusted to a measured recline angle of 25 degrees. The horizontal distance between the seat back and the mid point of the driver's air bag module was 65 cm (25.5"), measured 43 cm (17.0") above the seat bight. The driver was not restrained by the manual 3-point lap and shoulder belt system. The lack of safety belt usage was determined from the lack of loading evidence and the minimal historical wear evidence that was present of the belt system.

The driver applied a left steering input and a rapid brake application immediately prior to the crash. At impact, the frontal air bag system deployed. The driver responded to the frontal impact force by initiating a forward trajectory. Although there was no visible evidence on the deployed driver's air bag, the driver probably loaded the fully inflated air bag, which prevented potential contact with the steering assembly.

The driver was not injured during the crash and exited the vehicle unassisted and removed the front right child passenger from the vehicle.

Front Right Child Passenger

Age/Sex:	6-year-old/Female
Height:	91 cm (36")
Weight:	20 kg (43 lb)
Seat Track Position:	Mid-track position, adjusted 7.6 cm (3.0") forward of full rear and 13.0 cm (5.1") rear of full forward

Manual Restraint Use: None
Usage Source: Vehicle Inspection
Eyewear: None
Type of Medical Treatment: Expired at scene, did not receive medical treatment

Front Right Child Passenger Injuries

Injury	Injury Severity	Injury Source
Cervical spine fracture, NFS	Moderate (650216.2,6)	Air bag cover flap

Source of Injury: Lay Coroner – No autopsy performed.

Front Right Child Passenger Kinematics

The 6-year old front right passenger of the 1996 Ford Contour was reportedly kneeling on the front right seat prior to the crash. Although the driver stated that she was restrained by the lap belt, the evidence within the vehicle clearly supported that the child was not restrained. She was dressed in a T-shirt and shorts.

Immediately prior to impact, the driver steered left and braked in an attempt to avoid the crash. Although the braking force did not result in locked tire evidence on the asphalt road surface, the braking force did displace the child passenger in a forward direction. At impact, she was out-of-position forward with her head within close proximity to the top mount front right air bag module assembly. The crash resulted in the deployment of the frontal air bag system.

Figure 10 - Contact evidence to front right air bag tear flap

At deployment, the front right air bag module cover flap opened at the designated tear seams in an upward and forward direction. The leading edge of the flap struck the child passenger under the chin and accelerated the child in an upward direction as the air bag membrane began to expand from within the module. As a result of the interaction with the child, the cover flap deformed to a U-contour as evidenced in **Figure 10**.

The child's head struck the windshield directly above the air bag module. This contact was evidenced by the outward bowing fracture of the windshield and a large collection of hair embedded into the fractures of the laminated glazing.

The rearward expansion of the air bag membrane struck the child in the chest region and displaced the child rearward. Her head contacted the right sun visor and headliner, evidenced by a trail of hair in the fabric of these components. The hair extended to the mid point of the headliner as the child began to fall to rest.

The child passenger came to rest on the left rear aspect of the rear seat with her lower extremities positioned between the front seats. As the vehicle came to rest following the crash, the driver exited the vehicle from the left front door and immediately removed the child passenger from the left rear door of the vehicle. She was positioned on the lawn area adjacent to the crash site where the driver waited for emergency personnel to arrive on-scene.

Police and professional firefighters with paramedic certification arrived on-scene within minutes of the crash. The paramedics evaluated the condition of the child and initiated Cardio Pulmonary Resuscitation (CPR) in an attempt to regain vital signs (respiratory and pulse) of the child. After several minutes of CPR, the paramedics failed to regain the vitals and determined the child was deceased. The Coroner was summoned to the scene where the child was pronounced deceased. There was no medical transport or hospital intervention.

The Coroner arranged for transportation of the body to the morgue where an external only examination was conducted. The Coroner determined that the child sustained a fractured cervical spine without diagnostic verification. The Coroner also noted that the child did not sustain abrasions of the chin; however, she did not remove the cervical collar that was applied at the scene. It was concluded that the air bag cover flap was the injury mechanism based on the information provided by the Coroner, the child's kinematic pattern, the low delta-V from the impact, and the single impact configuration. The body was released to the family without autopsy.

Rear Right Passenger

Age/Sex:	14-year-old/Female
Height:	Not Available
Weight:	Not Available
Seat Track Position:	Not Adjustable
Manual Restraint Use:	None Used
Usage Source:	Vehicle Inspection
Eyewear:	Not Available
Type of Medical Treatment:	None

Additional Rear Infant Right Passenger on Lap

Age/Sex:	7-month-old/Female
Height:	Not Available
Weight:	Not Available
Seat Track Position:	Not Adjustable
Manual Restraint Use:	None Used
Usage Source:	Vehicle Inspection
Eyewear:	Not Available
Type of Medical Treatment:	None

Rear Right Passenger Kinematics

The 14-year old right rear passenger was seated in the vehicle and holding a 7-month old infant on her lap. The driver reported to the investigating officer that both occupants were restrained by the manual 3-point lap and shoulder belt system. Belt usage was ruled out due to the lack of injury to the infant passenger and the lack of loading evidence on the safety belt system.

At impact, the 14-year old occupant initiated a forward trajectory and possibly loaded the rear aspect of the front right seat back. She was apparently able to hold the infant during her forward motion. There were no contact points or damage to the rear seat area.

Immediately following the crash, the 14-year old exited the vehicle with the infant passenger and waited for emergency responders to arrive on scene. Neither rear seat passenger was injured or transported to a medical facility.

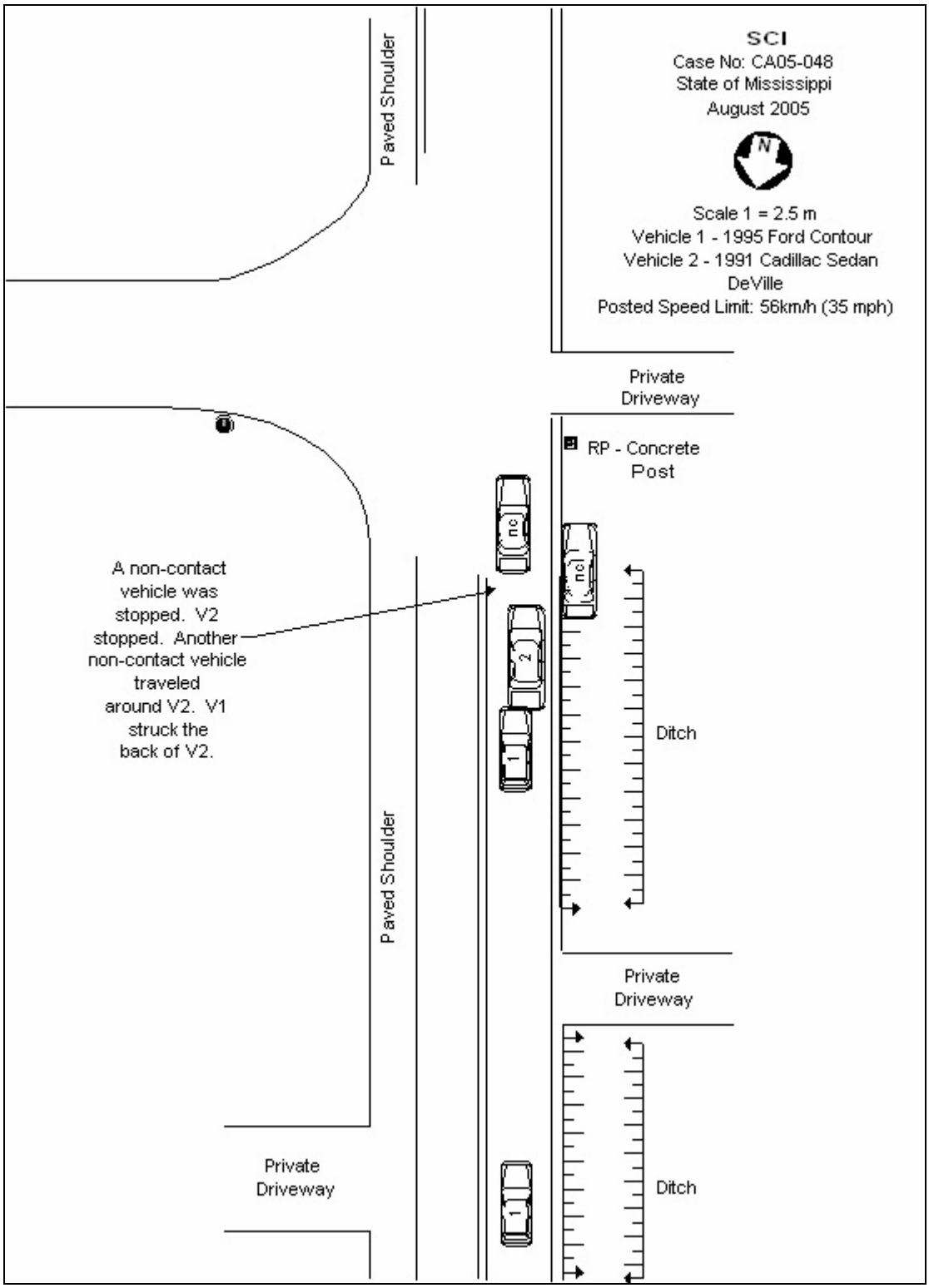

Figure 11 - Scene Schematic