

**TRANSPORTATION SCIENCES
Crash Research Section**

Veridian
Engineering Division
Buffalo, New York 14225

**VERIDIAN ON-SITE REDESIGNED AIR BAG INVESTIGATION
VERIDIAN CASE NO. CA00-004
VEHICLE: 1998 FORD CONTOUR
LOCATION: NORTH CAROLINA
CRASH DATE: JANUARY 2000**

Contract No.
DTNH22-94-D-07058

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. <i>Report No.</i> CA00-004	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Veridian On-Site Redesigned Air Bag Deployment Investigation Vehicle: 1998 Ford Contour Location: North Carolina		5. <i>Report Date:</i> September 2001	
		6. <i>Performing Organization Code</i>	
7. <i>Author(s)</i> Crash Data Research Center		8. <i>Performing Organization Report No.</i>	
9. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Data Research Center Veridian Engineering Division P.O. Box 400 Buffalo, New York 14225		10. <i>Work Unit No.</i> C01115.0264.(0000-0009)	
		11. <i>Contract or Grant No.</i> DTNH22-94-D-07058	
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date: January 2000	
		14. <i>Sponsoring Agency Code</i>	
15. <i>Supplementary Notes</i> On-site investigation of a three-vehicle crash that involved a 1998 Ford Contour equipped with redesigned frontal air bags.			
16. <i>Abstract</i> This on-site investigation focused on the injury mechanism that resulted in the death of a five year old female front right passenger of a 1998 Ford Contour. The Contour was involved in a severe head-on crash with a 1985 Chevrolet Camaro that resulted in deployment of the Contour's redesigned frontal air bag system. The child passenger was improperly restrained by the 3-point lap and shoulder belt system. She positioned the shoulder belt webbing behind her back which induced slack into the manual system. At impact, she initiated a forward trajectory into the deployed redesigned front right air bag. The air bag provided a sufficient ride down of her initial trajectory. The Camaro subsequently engaged with the right side of the Contour which redirected the child passenger laterally to her right. Her head impacted the intruding right upper A-pillar which resulted in a laceration of the right face/scalp, severe cerebral edema with obliteration of the basilar cisterns, and a small left subdural hematoma. She was flown to a regional trauma center where she expired within two hours of the crash.			
17. <i>Key Words</i> Redesigned air bag system deployment Improperly restrained child passenger Head impact to the right A-pillar Child fatality		18. <i>Distribution Statement</i> General Public	
19. <i>Security Classif. (of this report)</i> Unclassified	20. <i>Security Classif. (of this page)</i> Unclassified	21. <i>No. of Pages</i> 14	22. <i>Price</i>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	
Crash Site	1
Crash Sequence	
Pre-Crash	2
Crash	2
Post-Crash Events	3
Vehicle Data	
1998 Ford Contour	4
1985 Chevrolet Camaro	4
1995 Ford Contour	4
Vehicle Damage	
1998 Ford Contour - Exterior	4
Interior	5
1985 Chevrolet Camaro - Exterior	7
1995 Ford Thunderbird - Exterior	7
Manual Restraint System - 1998 Ford Contour	8
Redesigned Air Bag System	8
Driver Demographics	
1998 Ford	10
Driver Injuries	10
Driver Kinematics	11
Front Right Child Passenger Demographics	12
Front Right Child Passenger Injuries	12
Front Right Child Passenger Kinematics	13
Medical Treatment	13

VERIDIAN ON-SITE REDESIGNED AIR BAG DEPLOYMENT INVESTIGATION
VERIDIAN CASE NO. CA00-004
VEHICLE: 1998 FORD CONTOUR
LOCATION: NORTH CAROLINA
CRASH DATE: JANUARY 2000

BACKGROUND

This on-site investigation focused on the injury mechanism that resulted in the death of a five year old female front right passenger of a 1998 Ford Contour. The Contour (**Figure 1**) was involved in a severe head-on crash with a 1985 Chevrolet Camaro that resulted in deployment of the Contour's redesigned frontal air bag system. The child passenger was improperly restrained by the 3-point lap and shoulder belt system. She positioned the shoulder belt webbing behind her back which induced slack into the manual system. At impact, she initiated a forward trajectory into the deployed redesigned front right air bag. The air bag provided a sufficient ride down of her initial trajectory. The Camaro subsequently engaged with the right side of the Contour which redirected the child passenger laterally to her right. Her head impacted the intruding right upper A-pillar which resulted in a laceration of the right face/scalp, severe cerebral edema with obliteration of the basilar cisterns, and a small left subdural hematoma. She was flown to a regional trauma center where she expired within two hours of the crash.



Figure 1. Overall view of the damage to the Ford Contour.

The crash occurred in January 2000, in a rural area of North Carolina. The local medical examiner notified the staff of the child injury study at Philadelphia Children's Hospital of the fatal outcome of the front seat child passenger. Hospital personnel forwarded the notification to NHTSA's Special Crash Investigation Division. The case was assigned to the Veridian SCI team on February 2, 2000, as an on-site investigation due to the fatality and the redesigned air bag deployment. An on-site investigation was initiated on February 8th.

SUMMARY

Crash Site

The crash occurred on a rural two-lane U.S. route during nighttime hours. In the vicinity of the crash site, the dry asphalt road surface was straight with a positive grade of three percent to the east. A three-leg Y intersection was located approximately 83 m (272') west of the impact site. A left turn lane for westbound traffic originated west of the point of impact. The lane was formed by a widening of the asphalt surface in both directions of travel, therefore the eastbound approach to the crash location was curved slightly to the left. In this area, a painted flush median separated the travel lanes. There were no stabilized shoulders adjacent to the travel lanes. The posted speed limit was 89 km/h (55 mph).

Crash Sequence

Pre-Crash

The 1998 Ford Contour was traveling in an easterly direction (**Figure 2**) on the two-lane U.S. route at an estimated speed of 72-80 km/h (45-50 mph). The dark conditions warranted the use of headlights. The 33 year old female driver of the Contour was traveling through the curved segment of roadway as she approached the undivided straight segment. A 1995 Ford Thunderbird was traveling eastbound behind the Ford Contour at a comparable speed. The 1985 Chevrolet Camaro was traveling in a westerly direction (**Figure 3**) at a estimated speed of 80-89 km/h (50-55 mph). The intoxicated driver of the Camaro was operating the vehicle with unsafe tires as the steel belts in the right rear tire were exposed throughout the mid section of the tire. As he descended the negative grade, the Camaro driver lost control of the vehicle and crossed into the eastbound travel lane. There were no skid marks at the scene to support evasive action by the drivers of the Camaro and the Ford Contour. The Crash Schematic is attached as **Figure 16**.



Figure 2. Trajectory of the eastbound Ford Contour and Ford Thunderbird.



Figure 3. Trajectory of the westbound Chevrolet Camaro.

Crash

The frontal area of the Chevrolet Camaro impacted the front right area of the Ford Contour in a head-on, off-set configuration. Impact speeds were computed by the damage and trajectory algorithm of the WinSMASH program at 69.3 km/h (43.1 mph) for the Contour and 71.7 km/h (44.5 mph) for the Chevrolet Camaro. Resultant directions of force were within the 12 o'clock sector for both vehicles. The impact crushed the frontal structures of both vehicles as they began to rotate in a clockwise (CW) direction. Velocity changes were computed by WinSMASH at 56.4 km/h (35.0 mph) for the Contour and 53.7 km/h (33.4 mph) for the Camaro. The longitudinal components were of equal values due to 12 o'clock impact forces. As a result of the initial impact involving the frontal surface of the Contour, the vehicle's redesigned frontal air bags deployed.

The off-set impact configuration induced CW rotations to both vehicles. The frontal structure of the Camaro contacted the right side of the Contour in a continuous engagement pattern prior to separation. This continuous engagement influenced the trajectories of the occupants of the Contour, displacing them laterally to the right, toward the 1 o'clock sector.

The vehicles separated and rotated CW as they traveled on their respective post-crash trajectories. The Ford Contour crossed the westbound travel lane and departed the north (left) road edge. The vehicle came to rest on the grassy area adjacent to the roadway, facing in a southerly direction. The Ford's final rest position was located 9 m (30') north of its impact position. The vehicle rotated approximately 100 degrees CW following its impact with the Chevrolet Camaro.

The Camaro rotated approximately 120 degrees CW as its center of gravity continued in an easterly direction. The Camaro subsequently rotated into the path of the 1995 Ford Thunderbird that was following the Ford Contour.

The driver of the Thunderbird braked with sufficient force to lock the front wheels of his vehicle. The Thunderbird skidded in a tracking mode for a documented distance of 16.7 m (54.7'). This length of skid remained visible at the scene for a three week period prior to the notification and initiation of this on-site SCI investigation. The investigating officer measured a pre-crash skid distance of 24.1 m (79.0'). Based on this skid distance, the Thunderbird underwent an equivalent velocity loss due to braking of 66.4 km/h (41.3 mph).

The center and right frontal area of the Thunderbird subsequently impacted the left passenger side area of the Camaro, as the Chevrolet rotated into the Thunderbird's path of travel. Impact speeds were computed at 22.3 km/h (13.8 mph) for the Thunderbird and 13.9 km/h (8.6 mph) for the struck Camaro. Damaged based velocity changes were computed at 19.0 km/h (11.8 mph) for the Thunderbird and 33.0 km/h (20.5 mph) for the Camaro. It should be noted that the initial speed of the Ford Thunderbird was computed at 69 km/h (43 mph).

The Camaro was displaced in a CW direction and came to rest approximately 2 m (6.6') east of its at-impact position. At rest, the vehicle was facing in a northeasterly direction off-road with its left front tire straddling the south edge line.

The Ford Thunderbird skidded 1.5 m (0.9') forward before coming to rest diagonal to the eastbound travel lane. The Thunderbird rotated approximately 11 degrees CW during its post-crash trajectory.

Post-Crash Events

Passing motorists stopped at the crash scene to offer assistance to the involved parties. The crash was called-in to the emergency response system and police and emergency personnel were dispatched to the crash scene. The injured child passenger was removed from the Ford Contour by emergency medical technicians (EMTs) and transported by ambulance to a local fire station where she was transferred to a helicopter. The child was airlifted to a regional trauma center where she expired within two hours of the crash.

The driver of the Ford Contour was transported by ambulance to a local hospital where she was treated and released. The driver of the Chevrolet Camaro was transported by ambulance to a local hospital where

he was admitted for treatment of his injuries. Due to his intoxication and the fatal outcome of the crash, he was subsequently arrested for death by vehicle and jailed.

Vehicle Data

1998 Ford Contour

The subject vehicle was a 1998 Ford Contour, 4-door sedan that was manufactured in 01/98 and identified by vehicle identification number (VIN) 1FAFP6636WK (production number deleted). The vehicle was purchased by the driver's mother on 08/23/99 as a used vehicle from a local Ford dealership. At the time of purchase, the odometer reading was 56,803 km (35,291 miles). The crash occurred five months from the date of purchase and at the time of the crash, the odometer reading was 75,676 km (47,024 miles).

The Contour was equipped with redesigned frontal air bags for the driver and right passenger positions. In addition to the air bag system, the Contour was equipped with 3-point lap and shoulder belts for the five designated seated positions, front bucket seats with adjustable head restraints, and a folding back rear bench seat.

The Contour was powered by a 2.0 liter, 4-cylinder transverse mounted engine coupled to a 4-speed automatic overdrive transmission with a console mounted shifter. Braking was achieved by power-assisted front disc/rear drum brakes (without ABS). Power accessories included windows, door locks, and outside rear view mirrors.

1985 Chevrolet Camaro

The at fault vehicle in this crash was a 1985 Chevrolet Camaro. The vehicle was identified by vehicle identification number 1G1FP87H6FN1 (production number deleted). At the time of the crash, the odometer reading was 233,307 km (144,974 miles). The tires on the Camaro were in poor condition with steel belts exposed on the rear tires.

1995 Ford Thunderbird

The third vehicle in this crash was a 1995 Ford Thunderbird 40th Anniversary Edition. The vehicle was manufactured in 5/95 and identified by vehicle identification number 1FALP62W7SH (production number deleted). The vehicle was equipped with frontal air bags for the driver and front right positions which deployed as a result of the crash with the Camaro.

Vehicle Damage

1998 Ford Contour - Exterior

The Ford Contour sustained severe damage as a result of the off-set head-on crash with the 1985 Chevrolet Camaro. The Camaro initially impacted the front center and right areas of the Contour (**Figure 4**), crushing the frontal structure to a maximum depth of 78.1 cm (30.75"). The direct contact damage began 5.7 cm (2.25") right of center and extended 64.1 cm (25.25") to the front right corner. The impact deformed the full width of the frontal structure resulting in a combined induced and direct damage length

of 116.8 cm (46.0"). The front bumper fascia was separated from the vehicle, therefore the crush profile was documented at the level of the bumper reinforcement bar. The profile was as follows: C1 = 3.5 cm (1.4"), C2 = 10.9 cm (4.3"), C3 = 22.2 cm (8.75"), C4 = 35.6 cm (14.0"), C5 = 49.5 cm (19.5"), C6 = 78.1 cm (30.75"). **Figure 5** documents the overall damage to the Ford Contour.



Figure 4. Frontal damage to the Ford Contour.



Figure 5. Profile view documenting the extent of crush.

The initial off-set frontal engagement displaced the involved vehicles in a CW direction. During the rotation, the Camaro engaged the right side plane of the Ford. Although the contact was continuous with the frontal impact, the damage extended onto the Contour's right front fender and doors, terminating 10.2 cm (4.0") rearward of the right B-pillar.

Damaged components included all frontal components, the windshield, right front tire, wheel and suspension, the right A-pillar, and both right doors. The right front door was jammed closed due to the deformation and was opened with emergency tools by the fire department. All other doors remained closed and operational. Glazing damage consisted of fracture lines across the full width of the windshield and shattering of both front door glazings. The rear door glazing and backlight glass remained intact.

The Collision Deformation Classification (CDC) for this impact sequence was 12-FZEW-4. In addition to the frontal deformation, the right wheelbase was reduced in length by 33.0 cm (13.0").

Interior - 1998 Ford Contour

The interior of the Ford Contour sustained severe damage that was associated with exterior damage, air bag deployment, and occupant contact. The exterior deformation resulted in severe intrusion of the passenger compartment at the front right position. Maximum intrusion involved 31.8 cm (12.5") of rearward displacement of the right toe pan. The intruding component, occupant position, and magnitude are identified in the following table.

Table 1
Passenger Compartment Intrusions

Intruding Component	Occupant Position	Magnitude	Direction
Toe pan	Front left (driver)	10 cm (4")	Longitudinal
Upper A-pillar at header	Front right	8 cm (3")	Longitudinal
Mid A-pillar beltline	Front right	17 cm (7")	Longitudinal
Lower A-pillar	Front right	15 cm (6")	Longitudinal
Mid instrument panel	Front right	17 cm (7")	Longitudinal
Toe pan	Front right	33 cm (13")	Longitudinal

The air bag module cover flaps opened at the designated tear seams to allow deployment of the bag membranes. No damage was incurred by interior components as a result of the deployment.

Interior occupant contact points resulted in damage to interior components. The driver's knees impacted the knee bolster and the base of the steering column. The left knee contact scuffed and compressed the bolster to a residual depth of 1.3 cm (0.5"). The contact was located 50.8-58.4 cm (20.0-23.0") left of center and 31.0-40.6 cm (12.2-16.0") below the top of the upper instrument panel. The right knee contact was evidenced by a fabric transfer and a scuff to the right side of the column cover with continuation onto the bolster and the inboard aspect of the center console. The contact originated 25.4-38.1 cm (10.0-15.0") left of center and 30.4-41.9 cm (12.0-16.5") below the instrument panel. The plastic sub-panel fractured as a result of the knee contact and was crushed to a depth of 1.9 cm (0.75").

The driver's left hand separated from the steering wheel rim and fractured the column mounted turn signal stalk. The lateral aspect of her right thigh contacted and fractured the console mounted transmission selector lever. The alloy stem fractured at an elongated slot and the shifter was deflected toward the right A-pillar area (**Figure 6**). The driver's right arm subsequently impacted and displaced the upper center vent louver.



Figure 6. Deflection of the transmission shifter.

The driver's face contacted the deployed front left air bag as evidenced by a wide lipstick transfer. The transfer was located within the center tether reinforcement.

The child passenger loaded the deployed front right air bag. No contact evidence was visible on the bag. She continued to move laterally as the Camaro engaged the right side of the Contour. Her face and head impacted the intruding right upper A-pillar. A tissue transfer surrounded by body fluid and a scuff mark

evidenced the contact to the rigid plastic component. The contact began 14.0 cm (5.5") above the base of the pillar and extended 7.9 cm (3.1") vertically.

1985 Chevrolet Camaro - Exterior

The 1985 Chevrolet Camaro sustained severe frontal damage from its impact sequence with the Ford Contour. The direct damage length was 147.3 cm (58.0") which extended across the full width of the frontal plane. The fascia and filler panel separated from the bumper assembly, therefore the crush profile was documented at the reinforcement bar. Maximum crush was 111.1 cm (43.75") located at the front right corner. The crush profile at this level was as follows: C1 = 16.8 cm (6.6"), C2 = 43.8 cm (17.25"), C3 = 74.3 cm (29.25"), C4 = 101.0 cm (39.75"), C5 = 105.4 cm (41.5"), C6 = 111.1 cm (43.75"). The CDC for this impact sequence was 12-FDEW-4 (**Figure 7**).

The Camaro was subsequently struck on the left side by the Ford Thunderbird following the impact with the Ford Contour. The left side direct contact damage began 15.2 cm (6.0") rearward of the left rear axle position and extended 195.6 cm (77.0") forward to the leading edge of the front door. The combined induced and direct contact damage was 259.1 cm (102.0") which began 76.2 cm (30.0") rearward of the referenced axle, extending forward. The crush profile at the mid door level (**Figure 8**) was as follows: C1 = 0 cm, C2 = 7.4 cm (2.9"), C3 = 38.1 cm (15.0"), C4 = 44.4 cm (17.5"), C5 = 29.4 cm (11.6"), C6 = 0 cm. The CDC for this impact was 08-LZEW-3.



Figure 7. Frontal damage to the Chevrolet Camaro.



Figure 8. Left side damage from impact with the Ford Thunderbird.

1995 Ford Thunderbird - Exterior

The Thunderbird sustained moderate frontal damage from its impact sequence with the side of the Camaro. The direct contact damage began 37.4 cm (14.75") left of center and extended 104.1 cm (41.0") to the front right corner. The combined induced and direct damage length was 143.5 cm (56.5") which involved the full frontal width. The crush profile at bumper level was as follows: C1 = 0 cm, C2 = 2.9 cm (1.1"), C3 = 4.4 cm (1.75"), C4 = 7.0 cm (2.75"), C5 = 5.7 cm (2.25"), C6 = 21.3 cm (8.4"). The damage continued onto the right front fender, terminating 63.5 cm (25.0") rearward of the leading edge



Figure 9. Frontal damage to the Ford Thunderbird.

of the fender. This segment of the fender was crushed rearward 21.6 cm (8.5"). The CDC for this impact was 01-FZEW-1.

Manual Restraint System

1998 Ford Contour

The Contour was equipped with manual three-point lap and shoulder belts at the four outboard seated positions. The center rear position was equipped with a four-point lap and shoulder belt with a detachable shoulder belt webbing.

The front outboard systems utilized a continuous loop webbing and a sliding latchplate. The retractors were mounted in the lower B-pillars and were dual mode. The upper D-rings were adjustable with 7.6 cm (3.0") of vertical travel. The left D-ring was adjusted 2.5 cm (1.0") below the top adjustment point while the right D-ring was set to the full-down position. Both buckles were equipped with an energy management system that allowed a stitch pattern to separate under a load providing the occupants with a ride-down effect. Both management systems remained intact. The driver belt system did yield evidence of occasional usage, however, the system was not in use at the time of this crash.

The front right child passenger was improperly restrained by the 3-point system with the shoulder belt webbing positioned behind her back due to her small stature. Rescue personnel cut the lap and shoulder belt webbings, leaving the latchplate fastened into the mid mount buckle.

The lap belt webbing was cut 29.2 cm (11.5") from the latchplate while the shoulder belt webbing was cut 57.2 cm (22.5") above the latchplate (**Figure 10**). An 47.0 cm (18.5") length of lap belt webbing remained affixed to the outboard anchorage with the front right seat cushion. A body fluid stain (probable CSF fluid) was noted to the webbing in the area of the latchplate. A loading abrasion was observed to the plastic coating over the latchplate. The belt related abrasion was on the inboard aspect of the latchplate and was 6.4 cm (2.5") in width and 7.9 mm (7/16") in depth. There was no corresponding abrasion on the belt webbing. The latchplate was identified as TRW 326048A.

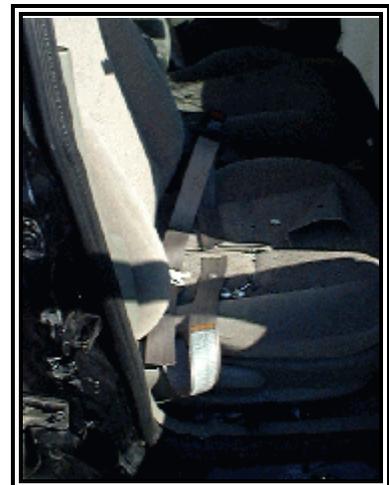


Figure 10. Cut front right belt webbing.

Redesigned Air Bag System

1998 Ford Contour

The subject vehicle (1998 Ford Contour) was equipped with redesigned frontal air bags for the driver and front right positions. The air bag system deployed as a result of the severe off-set, head-on crash with the 1985 Chevrolet Camaro. The system consisted of two front mounted electro-mechanical (ball-in-tube)

crash sensors, an interior mounted air bag control module, the steering wheel mounted driver air bag module, and a mid-mount front right air bag module.

The front crash sensors were mounted to the upper aspect of the radiator support panel, located 17.8 cm (7.0") on each side of the vehicle's center line (**Figure 11**). Both sensors remained intact and were not damaged. The left sensor was identified with Part No. 97BB-14B005-AF and bar coded label number AI27394283. The respective numbers for the right sensor were 97BB-14B004-AF and AH27497688.

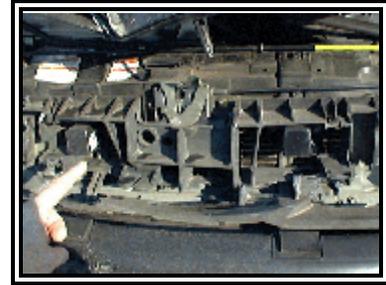


Figure 11. Front mounted crash sensors.

The front left (driver) air bag deployed from a typical steering wheel mounted module assembly. The wheel was configured with four spokes at the 3/9 and 5/7 o'clock positions. The H-configuration cover flaps were symmetrical in shape with overall dimensions of the upper flap of 19.1 cm (7.5") at the horizontal tear seam and 8.9 cm (3.5") vertically. The lower flap shared the same horizontal width with a vertical measurement of 7.6 cm (3.0"). Both flaps were contoured to the spokes of the wheel rim. The lower flap contained the acronym SRS (Supplemental Restraint System). There was no damage or contact evidence to the flaps.

The driver air bag membrane was approximately 58.4 cm (23.0") in diameter in its deflated state. The bag was vented by two 1.5 cm (0.6") diameter vent ports located at the 11:30 and 12:30 o'clock sectors on the back side of the bag, centered 6.4 cm (2.5") below the peripheral seam. Internally, the bag was tethered by four straps which were sewn to the face of the bag with a 17.8 cm (7.0") diameter reinforcement. The straps were positioned at the 10/2 and 4/8 o'clock locations.

The driver's face contacted the deployed front left air bag as it was fully inflated. This was evidenced by a lipstick transfer to the center face of the bag over the tether reinforcement (**Figure 12**). The upper and lower lip transfer began in a distinct pattern then smeared laterally to the right as the driver's trajectory was modified to the right. The transfer began 4.4 cm (1.75") left of center and extended 8.3 cm (3.25") to the right. Vertically, the transfer was located 0-3.2 cm (0-1.25") below the bag's horizontal center line.



Figure 12. Lipstick transfer on the front left air bag.

In addition to the lipstick transfer on the front left air bag, vinyl expansion transfers were noted to the bag from expansion against the inside surface of the flaps and module. These were normal transfers associated with the deployment and not the result of an out-of-position driver.

The front right air bag was mounted in a module that was concealed within a single cover flap in the right upper and mid instrument panel. The hinge point of the flap was positioned at the top of the module cover which allowed the flap to open in an upward direction. The vinyl exterior skin of the flap was backed by a sheet metal liner which provided rigidity to the flap and acted as the internal hinge. Post deployment, the flap was positioned vertically, approximately 90 degrees to the instrument panel. The overall dimensions of the flap were 36.8 x 16.5 cm (14.5 x 6.5"). The SRS acronym was molded into the lower right corner of the flap.

The air bag membrane was tethered by two 7.6 cm (3.0") wide straps that were sewn to the face of the bag, positioned 22.9 cm (9.0") inboard of the vertical side seams. The overall dimensions of the bag was 48.3 cm (19.0") vertically and 68.6 cm 27.0") horizontally (**Figure 13**). The bag was vented by a single port located at the 9 o'clock sector of the bag at the upper inboard corner. The port was 3.6 cm (1.4") in diameter. There was no damage or contact evidence to the bag.



Figure 13. Overall view of the deployed front right air bag.

Driver Demographics

1998 Ford Contour

Age/Sex: 23 year old female
 Height: 165.1 cm (65.0")
 Weight: 59 kg (130 lb)
 Eyeware: Unknown
 Manual Restraint
 Usage: None
 Usage Source: Vehicle inspection
 Mode of Transport
 From Scene: Ambulance
 Type of Medical
 Treatment: Treated at a local hospital and released

Driver Injuries

Injury	Injury Severity (AIS 90, Update 98)	Injury Mechanism
Fractured ribs (NFS)	Minor (450299.1,9)	Steering wheel rim/redesigned front left air bag

Driver Kinematics

The driver of the Ford Contour was seated in a upright driving position with the manually adjusted seat track set to a mid track position. The seat back was reclined approximately 20 degrees with the adjustable head restraint set to the full down position. Both hands were positioned on the steering wheel rim in the lateral positions of 3 and 9 o'clock and her right foot was positioned on the brake pedal. She was not wearing the manual belt system. Non-use of the belt system was supported by the lack of loading evidence on the belt webbing, her trajectory and interior contact points, and the non-deployment of the management loop incorporated into the buckle assembly.



Figure 14. Driver trajectory and contact points.

At impact, the driver initiated a forward trajectory and loaded the fully deployed front left air bag with her facial and upper thoracic areas. This contact was supported by a lipstick transfer to the mid point of the bag. The driver's left hand separated from the steering wheel rim and fractured the column mounted turn signal stalk. Her knees impacted the knee bolster and the steering column cover. The left knee contact was evidenced by a scuff mark and forward compression of the plastic bolster panel. The right knee contact was evidence by fabric transfers and a scuff mark on the right side of the steering column cover. The plastic sub panel was fractured with 1.9 cm (0.75") of forward displacement. No injury resulted from these contact points. The driver's right foot loaded the brake pedal as evidence by a scuff mark on the pedal. Again, no injury resulted from this contact.

The driver's torso loaded the deployed front left air bag and compressed the bag against the steering assembly. This loading through the bag into the steering assembly resulted in police reported rib fractures. There was no deformation of the steering wheel rim or compression of the convoluted lower steering column shaft.

As the Camaro engaged the right side of the Ford Contour, the driver's trajectory was deflected toward the 1 o'clock sector. This was evidenced by the elongation of the lipstick transfer on the deployed air bag and the continuation of the right knee contact. The scuff mark and fabric transfer from the right knee continued into the center mid panel and console components.

At this point, the driver began to moved laterally to the right. Her right lateral thigh impacted the console mounted automatic transmission shifter and fractured the "soft metal" shaft. As a result, the shifter was deflected toward the 1 o'clock sector. Her right upper arm and/or shoulder area impacted the mid upper instrument panel mounted vent louvers and displaced the louver assembly into the venting cavity. No injuries resulted from these latter contact points. **Figure 14** is an overall view of the driver's trajectory and contact points.

Front Right Child Passenger Demographics

Age/Sex: 5 year old female
 Height: 106.7 cm (42.0")
 Weight: 18.6 kg (41.0 lb)
 Manual Restraint
 Usage: Lap belt with shoulder belt positioned behind back
 Usage Source: Observations of the EMTs, interior contact points, belt webbing cut near latchplate
 Mode of Transport
 From Scene: Removed from vehicle by emergency medical technicians, transported to a local fire station where she was flown by helicopter to a regional trauma center
 GCS: 3
 Type of Medical
 Treatment: Evaluated and treated at the center where she was diagnosed with brain death and expired within two hours of the crash

Front Right Child Passenger Injuries

Injury	Injury Severity (AIS-90, Update 98)	Injury Mechanism
Severe cerebral edema with obliteration of the basilar cisterns with left to right shift (<i>CSF leakage was noted from the nose, however, no definitive skull fractures were visible in the CT scans</i>)	Critical (140666.5,9)	Intruding right upper A-pillar
Left subdural hematoma	Severe (140652.4,2)	Intruding right upper A-pillar
3 cm linear laceration over the right temporal and zygomatic area	Minor (290602.1,1)	Intruding right upper A-pillar
Bilateral periorbital ecchymosis with edema	Minor (297402.1,1; 297401.1,2)	Intruding right upper A-pillar
Abrasion across the mid abdomen at the level of the umbilicus	Minor (590202.1,4)	Lap belt webbing

** All injuries were noted in the hospital medical records; no autopsy was performed.*

Front Right Child Passenger Kinematics

The child passenger was seated in the front right position with the seat track adjusted to a mid position and the back rest reclined to 23 degrees. Due to her small stature, she was probably forward on the cushion which allowed her knees to clear the leading edge of the seat cushion. The child was wearing the manual belt system, however, the shoulder belt webbing was positioned behind her back. This would have induced slack in the belt system.

There was no evidence of pre-crash braking at the scene, however, the driver's foot was positioned on the pedal at impact. The frontal air bag system deployed as a result of the severe frontal impact sequence with the Chevrolet Camaro. The child passenger initiated a forward trajectory in response to the 12 o'clock impact force and moved into the fully deployed redesigned front right air bag. There was no occupant contact evidence on the bag or bag induced injury to the child passenger. The bag was effective at this point to protect the child from serious injury during her initial trajectory. She loaded the lap belt webbing which produced an abrasion over the mid abdominal area at the umbilicus.

As the Camaro engaged the right side surface of the Ford Contour, the child passenger responded by moving laterally right and forward. Her head moved outboard of the protective area of the front right air bag and impacted the intruding right upper A-pillar. A scuff mark with a tissue transfer and body fluid transfers were noted to the rigid plastic trim cover of the pillar. The contact was located 14.0-21.8 cm (5.5-8.6") above the base of the cover (**Figure 15**). As a result of the contact to this rigid component, the child sustained a linear laceration of the right temporal and zygomatic area, severe cerebral edema with obliteration of the basilar cisterns, a small subdural hematoma, and bilateral ecchymosis.



Figure 15. Head contact evidence to the right A-pillar cover.

The child rebounded from these contacts and came to rest slumped in the right front seat. Emergency medical technicians (EMTs) responded to the crash scene and cut the lap and shoulder belt webbing to remove the child from the vehicle. She was transported by ambulance to the local fire station where she was transferred to a helicopter that transported her to a regional trauma center.

Medical Treatment

The child was intubated at the scene by the EMTs. On arrival at the trauma center, the child's Glasgow Coma Score (GCS) was 3. Cerebral spinal fluid (CSF) was observed to be leaking from her nose. The attending physician noted no palpable skull or facial fractures. She was administered 10 mg of Mannitol IV and 200 cc of Hespan. She was taken to the CT suite where a CT scan of the brain was performed which revealed the above injuries. The child was transferred to nuclear medicine where an isotope study was performed which revealed no blood flow to the brain. She was diagnosed with brain death and expired approximately 2 hours post-crash. No autopsy was performed.

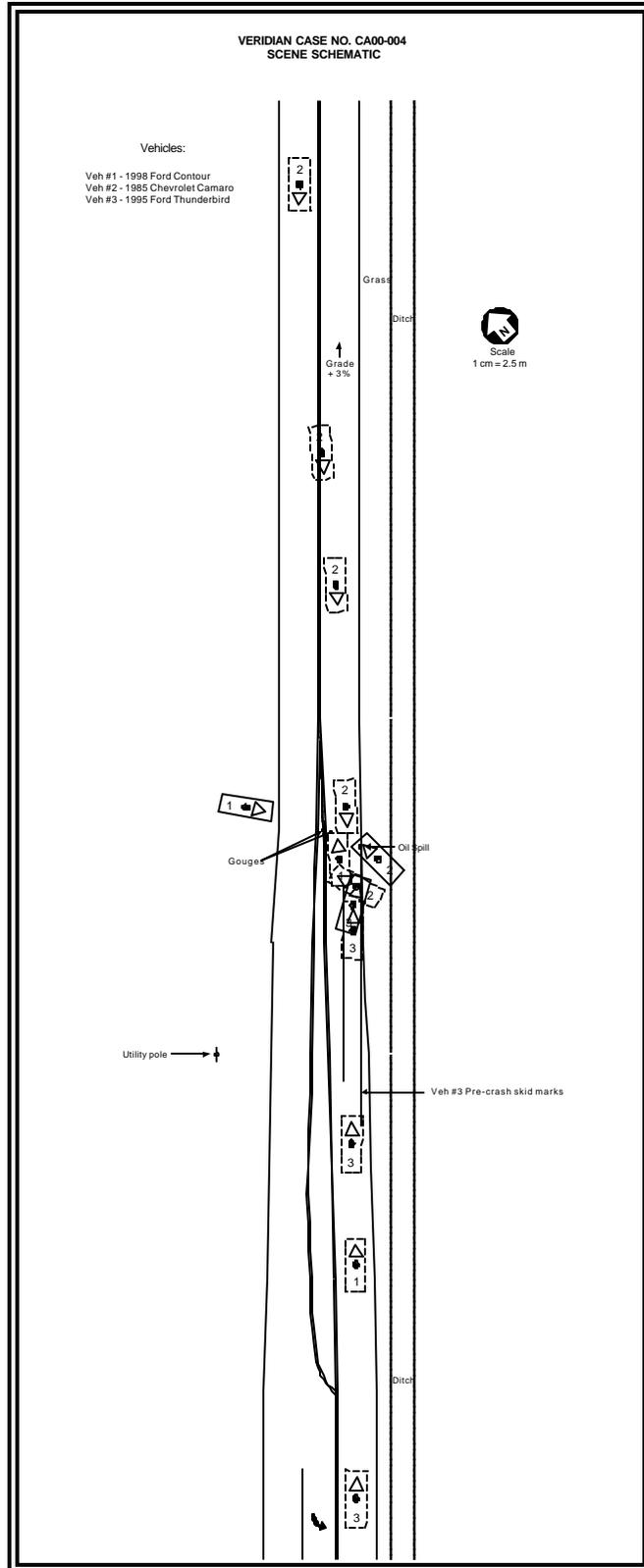


Figure 16. Crash Schematic