

**TRANSPORTATION SCIENCES
Crash Data Research Center**

Veridian
Engineering Division
Buffalo, New York 14225

**VERIDIAN ON-SITE ADVANCED OCCUPANT PROTECTION
SYSTEMS INVESTIGATION
VERIDIAN CASE NO. CA00-059
VEHICLE: 2000 FORD TAURUS
LOCATION: VIRGINIA
CRASH DATE: NOVEMBER 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> CA00-059	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Veridian On-Site Advanced Occupant Protection Systems Investigation Vehicle: 2000 Ford Taurus Location: Virginia		5. <i>Report Date:</i> June, 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 P.O. Box 400 Buffalo, New York 14225		10. <i>Work Unit No.</i> C01115.0324.(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: November 2000	
		14. <i>Sponsoring Agency Code</i>	
15. <i>Supplementary Notes</i> On-site investigation of a 2000 Ford Taurus crash that resulted in deployment of the frontal Advance Occupant Protection System (AOPS).			
16. <i>Abstract</i> <p>This on-site investigation focused on a 2000 Ford Taurus that was equipped with an Advanced Occupant Protection System (AOPS) and an Event Data Recorder (EDR). The vehicle was involved in an intersection crash with a subsequent sideslap with a 1993 Mercury Tracer. The Taurus' frontal impact resulted in deployment of the frontal air bag system, firing of the driver's pre-tensioner, and recording of the crash event by the EDR. The driver of the Taurus was not injured in the crash, however, the front right passenger sustained multiple soft tissue injuries. The driver of the Tracer was restrained by a 2-point motorized shoulder belt. She loaded the belt which resulted in an occult liver laceration. She expired approximately four hours following the crash. A 4 year old female was restrained in the center rear of the Tracer in a forward facing child safety seat. She, and an adult right rear passenger of the Tracer sustained minor injuries.</p>			
17. <i>Key Words</i> Frontal air bag deployment Driver buckle pre-tensioner firing Belted driver, unbelted front right passenger Passenger injures		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> 17	22. <i>Price</i>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	
Crash Site	1
Vehicle Data	
2000 Ford Taurus	2
1993 Mercury Tracer	2
Crash Sequence	
Pre-Crash	2
Crash	3
Post-Crash	4
Vehicle Damage	
Ford Taurus - Exterior	4
Ford Taurus - Interior	6
1993 Mercury Tracer - Exterior	7
1993 Mercury Tracer - Interior	7
Manual Restraint Systems - 2000 Ford Taurus	7
Advanced Occupant Protection System (AOPS)	8
Event Data Recorder Output	9
Occupant Demographics	
2000 Ford Taurus Driver	10
Driver Injuries	10
Driver Kinematics	10
Front Right Passenger Demographics	12
Front Right Passenger Injuries	12
Front Right Passenger Kinematics	12
Mercury Tracer	13
Attachment A: EDR Output	16

**VERIDIAN ON-SITE ADVANCED OCCUPANT PROTECTION
SYSTEMS INVESTIGATION
VERIDIAN CASE NO. CA00-059
VEHICLE: 2000 FORD TAURUS
LOCATION: VIRGINIA
CRASH DATE: NOVEMBER 2000**

BACKGROUND

This on-site investigation focused on a 2000 Ford Taurus that was equipped with an Advanced Occupant Protection System (AOPS) and an Event Data Recorder (EDR). The vehicle was involved in an intersection crash with a subsequent sideslap (**Figure 1**) with a 1993 Mercury Tracer. The Taurus' frontal impact resulted in deployment of the frontal air bag system, firing of the driver's pre-tensioner, and recording of the crash event by the EDR. The driver of the Taurus was not injured in the crash, however, the front right passenger sustained multiple soft tissue injuries. The driver of the Tracer was restrained by a 2-point motorized shoulder belt. She loaded the belt which resulted in an occult liver laceration. She expired approximately four hours following the crash. A 4 year old female was restrained in the center rear of the Tracer in a forward facing child safety seat. She, and an adult right rear passenger of the Tracer sustained minor injuries.



Figure 1. Front and side damage to the 2000 Ford Taurus.

Notification of the November crash was provided to NHTSA by a Virginia County Police Department on Thursday, December 7. The notification was immediately forwarded to the Veridian SCI team and assigned as an on-site investigative effort. Due to travel conflicts within the SCI program, the on-site investigation was scheduled for Friday, December 15.

SUMMARY

Crash Site

The crash occurred at an urban four-leg oblique intersection of two divided roadways. Traffic flow through the intersection was controlled by a pre-timed, overhead signal system with designated left and right turn arrows. The Ford Taurus was traveling eastbound on an approach to the intersection. The eastbound lanes consisted of three through lanes with a designated left turn and a right turn lane that was separated from the intersection by a raised gore area. The westbound lanes were straight with an estimated negative grade of two percent to the west.

The 1993 Mercury Tracer was traveling in a westerly direction on an approach to the signalized intersection. The westbound lanes at the east leg of the intersection consisted of three through lanes with the designated left and right turn lanes configured the same as the opposing lanes. Again the alignment was straight with a positive grade at the intersection of approximately two percent.

The crash occurred during nighttime hours, however, the intersection was illuminated at all four corners. The asphalt road surface was in good condition and was dry. The weather conditions were clear and the grades afforded both drivers an ample line of sight on approach to the intersection. The crash schematic is included as **Figure 16**, Page 16 of this summary report.

Vehicle Data

2000 Ford Taurus

The subject vehicle for this investigation was a 2000 Ford Taurus SE that was equipped with an Advanced Occupant Protection System (AOPS). The AOPS consisted of dual stage inflators for the frontal air bags, a left front seat positioning sensor, front seat belt buckle pre-tensioners, load limiter retractors for the front outboard belt systems, and an Event Data Recorder (EDR). The EDR data was downloaded during the on-site inspection of the vehicle and electronically forwarded to Ford. The results were not received at the time of this summary submission.

In addition to the AOPS, the Taurus was equipped with 3-point lap and shoulder belts for the four outboard seated positions and lap belts for the center front and center rear positions. The interior was configured with a bucket front seats and a flip-and-fold center seat/console. At the time of the crash, this unit was folded forward into a console configuration. The seats were covered with the leather trim option. Power accessories included windows, door locks, driver's seat adjustment, and adjustable foot controls. The Taurus was not equipped with side impact air bags. The Taurus was manufactured in 05/00, and was identified by vehicle identification number 1FAFP55UXYG (production number deleted).

1993 Mercury Tracer

The initial vehicle struck by the 2000 Ford Taurus was a 1993 Mercury Tracer, 4-door sedan. The Tracer was manufactured on 09/93 and was identified by vehicle identification number 3MAPM10J1PR (production number deleted). At the time of the crash, the vehicle's odometer reading was 138,068 km (85,794 miles).

The Tracer was equipped with front bucket seats and a rear bench with a folding seat back. The front outboard restraint systems consisted of 2-point motorized shoulder belts with manual lap belts. The rear seat was configured with 3-point lap and shoulder belts for the outboard positions and a center rear lap belt. It should be noted that the driver of the Tracer was restrained solely by the shoulder belt system. She sustained an occult liver injury and expired approximately four hours following the crash.

Crash Sequence

Pre-Crash

The Ford Taurus was traveling in a easterly direction on a multi-lane divided roadway at a driver estimated speed of 77 km/h (48 mph). He approached the four-leg intersection on a green signal phase and proceeded into the intersection (**Figure 2**) to continue eastbound. The driver of the Mercury Tracer was

westbound (**Figure 3**) on the opposing side of the highway. She decelerated and stopped at the mouth of the intersection in preparation for a left turn at the intersection. The driver of the Tracer failed to detect the Taurus and initiated a left turn across the Taurus' path of travel. The driver of the Taurus braked the ABS equipped vehicle in an attempt to avoid the impending impact.



Figure 2. Pre-crash trajectory of the Ford Taurus.



Figure 3. Pre-crash Trajectory of the Mercury Tracer.

Crash

The full frontal area of the Taurus impacted the right front side area of the Tracer resulting in respective directions of force of 11 and 2 o'clock. The front bumper beam of the Taurus crushed to a maximum depth of 31.1 cm (12.75") located 11.4 cm (4.5") right of center. The vehicle underwent a WinSMASH generated velocity change of 23.4 km/h (14.5 mph) with a longitudinal component of -20.2 km/h (-12.5 mph) and lateral component of 11.7 km/h (7.3 mph). The longitudinal component was sufficient to deploy the first stage of the Taurus' frontal air bag system and the driver's seat belt buckle pre-tensioner. The Tracer crushed to a depth of 30.7 cm (12.1") and underwent a velocity change of 36.1 km/h (22.4 mph) with a longitudinal component of -18.1 km/h (-11.2 mph) and lateral component of -31.3 km/h (-19.4 mph). It should be noted that the velocity changes for the Taurus were low considering the severity of damage. A more reasonable velocity change for the Taurus, based on SCI experience, would be within the range of 24-29 km/h (15-18 mph). The event data recorder of the Taurus captured a longitudinal delta V of 31.7 km/h (-19.7 mph) at 78 milliseconds and a lateral delta V of 18.7 km/h (11.6 mph).

The impact rotated the Taurus in a clockwise (CW) direction as the Tracer rotated counterclockwise (CCW). The vehicle's impacted in a sideslap configuration resulting in force directions of 9 o'clock for the Taurus and 3 o'clock for the Tracer. The left rear door, wheel, and quarter panel of the Tracer impacted the left side doors of the Taurus. The damage algorithm of the WinSMASH program computed velocity changes of 8.9 km/h (5.5 mph) and 13.8 km/h (8.6 mph) for the Taurus and Tracer respectively.

The Ford Taurus continued to rotate in a CW direction into the south leg of the intersection. The left rear bumper corner impacted the frontal area of a stopped 1999 Hyundai Elantra as the Taurus came to rest. The 8 o'clock direction of force impact resulted in a minor depression of the Taurus' left rear bumper fascia. There was no structural involvement of the bumper beam. The damage to the Hyundai was police

reported as minor. The Taurus came to rest approximately 9.8 m (32.0') southeast of its initial impact location, facing in a northwesterly direction. At rest, the Taurus had rotated approximately 260 degrees in a CW direction.

Following the sideslap impact, the Tracer was deflected in a southeasterly direction. The vehicle traversed the painted gore area and the right turn lane prior to departing the southeast quadrant of the intersection in a tracking orientation. The vehicle came to rest approximately 27.4 m (90.0') east of its initial point of impact with the Ford Taurus.

Post-Crash

The driver of the Ford Taurus came to rest in an upright seated posture in the left front of the vehicle. He stated that at final rest, the front right passenger was positioned against the steering wheel rim with her head forward of his position. She slid back into the front right seat as the driver attempted to open his door. The driver subsequently crawled into the rear seat of the Taurus and exited the vehicle through the shattered left rear door window opening. During this effort, his hands contacted the glass fragments which lacerated his finger. As he exited the vehicle, the driver opened the left front door from the outside and assisted the front right passenger from the vehicle. She slid out the left front door and immediately sat sideways on the front left seat cushion and waited for emergency personnel to arrive on-scene.

Vehicle Damage

Ford Taurus - Exterior

Primary - The full frontal area of the Taurus impacted the right front side area of the Tracer in an L-configuration impact sequence. As a result, the Taurus sustained moderate frontal damage (**Figure 4**) with a maximum crush value of 31.1 cm (12.25") located on the bumper beam 11.4 cm (4.5") left of the vehicle's centerline. The direct contact damage began at the front left corner of the bumper fascia and extended 130.2 cm (51.25") to the right. The impact displaced the bumper fascia and fractured the styrofoam filler panel, therefore the fascia was lowered and a crush profile was documented at the level of the bumper beam. The crush profile was documented along the profile of the bumper beam with a "Field L" damage length of 127.3 cm (50.1"). The following crush values are residual values with deductions made for free-space (contour, fascia, and filler panel): C1 = 12.1 cm (4.75"), C2 = 24.4 cm (9.6"), C3 = 30.7" cm (12.1"), C4 = 22.2 cm (8.75"), C5 = 14.6 cm (5.75"), C6 = 8.3 cm (3.25"). **Figure 5** is a profile view of the crush profile.

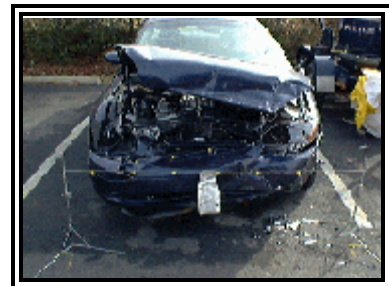


Figure 4. Frontal damage to the Ford Taurus.

Components damaged by the initial impact included the front bumper system, grille, both headlight and turn signal assemblies, hood, both front fenders, upper radiator support panel, air conditioning condenser, and the radiator.



Figure 5. Profile view documenting the extent of frontal crush.



Figure 6. Left side sideslap damage.

Secondary - The Taurus was involved in a secondary sideslap impact sequence with the Tracer as both vehicles were deflected in opposite directions by the initial impact. The lateral 9 o'clock impact resulted in moderate damage to the left side doors of the Taurus (**Figure 6**). The direct contact damage began 52.1 cm (20.5") rearward of the left front axle position and extended 127 cm (50") to the rear, terminating 74.9 cm (29.5") forward of the left rear axle. The combined induced and direct contact damage began at the same start point and extended 211.8 cm (83.4") rearward, ending 16.2 cm (6.4") forward of the rear axle position. A crush profile was documented at the level of the rub strip and was as follows: C1 = 0 cm , C2 = 5.7 cm (2.25"), C3 = 8.3 cm (3.25"), C4 = 6.4 cm (2.5"), C5 = 3.5 cm (1.4"), C6 = 0 cm. Damaged components included both left doors, the leading edge of the left rear quarter panel, and the left rear door glazing.

The Taurus was involved in a third impact sequence with a stopped 1999 Hyundai Elantra. The post-crash clockwise rotation of the Taurus resulted in the left rear corner area of the bumper fascia impacting the front left corner area of the Hyundai. The Taurus' direct contact damage began 61.2 cm (24.1") left of center and extended 9.9 cm (3.9") to the corner. The damage resulted in a large dent to the bumper fascia(**Figure 7**) with no residual crush to underlying structural components.



Figure 7. Left rear bumper fascia impact damage.

Collision Deformation Classification (CDC)

<i>Event No.</i>	<i>Object Struck</i>	<i>CDC</i>
1	1993 Mercury Tracer	71-FDEW-2*
2	1993 Mercury Tracer	09-LPEW-3
3	1999 Hyundai Elantra	08-BLLS-1

* The direction of force for the initial impact was incremented by a value of 60 to represent the lateral shift to the right.

The passenger compartment of the Taurus remained intact with no intrusion. Both right side doors and the left front door remained closed during the crash and were operational post-crash. The left rear door was jammed closed due to damage. All glazing remained intact with the exception of the left rear door glazing which shattered as a result of the sideslap.

2000 Ford Taurus - Interior

The interior damage to the Ford Taurus was a result of occupant contact and deployment of the AOPS. There was no damage associated with exterior damage or intrusion of interior components. The frontal air bag system deployed as designed from the respective module assemblies. The driver was restrained by the manual belt system, therefore the buckle pre-tensioner fired.

The driver loaded the manual belt system, however, there was no damage or loading evidence associated with his loading force. He braced against the steering wheel rim with both hands at driver estimated positions of 3 and 9 o'clock. The combination of his bracing action and the subsequent loading of the steering wheel rim by the unrestrained front right passenger resulted in deflection of the wheel hub and 2.5 cm (1.0") of left shear capsule separation and the fracture of the right shear bracket (**Figure 8**). The driver also braced with his right foot against the brake pedal as he braked with full force in an attempt to avoid the crash. His braking and loading force as he responded to the frontal impact force resulted in deflection of the adjustable brake pedal to the right.

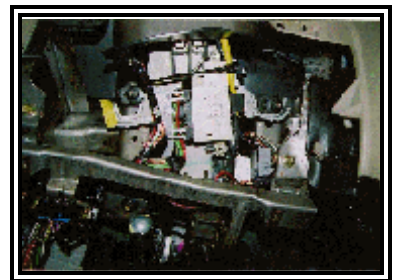


Figure 8. Shear bracket separation.

The unrestrained front right passenger initiated a trajectory that was forward and left with continued lateral motion due to the CW rotation and the left sideslap impact sequence. Her left knee/lower leg contacted the left side of the glove box door and flip-and-fold center console. The console was scuffed, but not displaced laterally. Her right knee subsequently impacted the left side of the glove box door and was pocketed between the door and the mid panel. A large black fabric transfer was located on the left side of the glove box door that extended 8.3 cm (3.25") from the left edge and extended the full height of the component. The glove box was separated from the lower right instrument panel.

The forward component of the passenger's trajectory resulted in her loading the deployed front right air bag. She deflected the deployed air bag forward as evidenced by a membrane transfer on the right aspect of the windshield. The faint fabric transfer was located 40.6-46.4 cm (16.0-18.25") right of center and 25.4-34.9 cm (10.0-13.75") below the windshield header.

The lateral component of her trajectory resulted in probable right upper extremity/shoulder contact with the rear view mirror. The mirror was displaced from its pre-crash adjusted position to the left. The passenger's left chest area subsequently impacted the right edge of the steering wheel rim which contributed

to the damage/deflection noted above. A 7.6 cm (3.0") vertical scuff mark on the outboard aspect of the wheel rim verified the passenger's contact location.

As she continued laterally, the passenger's left scalp area impacted the inboard aspect of the driver's sun visor and pivot/mounting bracket. In addition to a large transfer of hair with tissue, the plastic component was fractured with compression of the padded visor. This contact was located 15.2-20.9 cm (6.0-8.25") left of center and 5.7-10.2 cm (2.25-4.0") rearward of the windshield header.

1993 Mercury Tracer - Exterior

Primary - The right front side area (**Figure 9**) of the Tracer was impacted by the Ford Taurus resulting in a 02 o'clock impact force. The direct damage began at the front right bumper corner and extended 172.7 cm (68.0") rearward, terminating at a point on the right front door that was 141.6 cm (55.75") forward of the right rear axle position. Maximum lateral crush was 30.7 cm (12.1") located on the right front fender, 17.8 cm (7.0") forward of the right A-pillar. The combined induced and direct contact damage began at the right B-pillar and extended 215.9 cm (85.0") forward to the right front bumper corner. The crush profile was documented at the level of the rub strip and was as follows: C1 = 0 cm, C2 = 1 cm (0.4"), C3 = 15.9 cm (6.25"), C4 = 23.2 cm (9.2"), C5 = 25.7 cm (10.1"), C6 = 30.5 cm (12.0").



Figure 9. Front and rear impact damage to the right side of the Tracer.

Secondary - The secondary sideslap impact with the Ford Taurus resulted in moderate damage to the right rear side area (**Figure 9**) of the Tracer. Maximum crush was 15.2 cm (6.0") located at C2, 54.6 cm (21.5") rearward of the right rear axle. The direct contact damage began 32.3 cm (12.75") forward of the right rear axle and extended 125.7 cm (49.5") to the right rear bumper corner. The combined induced and direct contact damage began 99.7 cm (39.25") forward of the referenced axle and extended 193.0 cm (76.0") to the bumper corner. The crush profile was documented at the level of the rub strip and was as follows: C1 = 14.0 cm (5.5"), C2 = 15.2 cm (6.0"), C3 = 3.0 cm (1.2"), C4 = 0.5 cm (0.2"), C5 = 0 cm [-2.8 cm (-1.1")], C6 = 0 cm. The sideslap damaged the right corner of the rear bumper, the right quarter panel, and the right rear door.

Collision Deformation Classification (CDC)

<i>Event No.</i>	<i>Object Struck</i>	<i>CDC</i>
1	2000 Ford Taurus	02-RYEW-3
2	2000 Ford Taurus	03-RZEW-3

1993 Mercury Tracer - Interior

The interior of the Mercury sustained minimal damage that was associated with lateral intrusion of the right A-pillar. There was no contact evidence from occupant loading.

Manual Restraint Systems - 2000 Ford Taurus

The Ford Taurus was equipped with 3-point lap and shoulder belts for the front outboard and three rear seat positions. The center front position was equipped with a manual lap belt. This position was not available due to the forward position of the center flip-and-fold seat/console.

The front belt systems consisted of continuous loop webbings, fitted with sliding latchplates. The webbings retracted onto lower B-pillar mounted dual mode (belt sensitive and inertia activated) retractors. The retractors incorporated load force limiters that consisted of torsion bar axles. The inboard mounted buckles were equipped with pre-tensioners. These are addressed in the AOPS section of this summary report.

The driver of the Taurus was properly restrained by the manual 3-point lap and shoulder belt system. He loaded the belt webbing during the crash phase and braced against the steering wheel and brake pedal. There was no evidence on the belt webbing or hardware components, however, the pre-tensioner did fire.

The front right passenger of the Taurus was not restrained by the manual system. She alleged that she had worn the system at the on-set of this trip, however, failed to re-buckle the belt as they departed a restaurant. The belt system did yield faint evidence of routine usage. The front right pre-tensioner did not fire, confirming the system was not buckled.

Advanced Occupant Protection System (AOPS)

The 2000 Ford Taurus was equipped with an AOPS that consisted of frontal air bags with dual stage inflators for the driver and right passenger positions, a driver's seat positioning sensor, front seat belt buckle pre-tensioners, and an event data recorder (EDR). The AOPS was controlled by a Restraints Control Module (RCM) that monitored crash severity, belt usage, and the driver's seat position. Based on the severity of the crash and usage of the manual belt systems, the RCM could deploy the frontal air bags at various thresholds. The RCM had the capability to record crash data. This data was downloaded during the on-site investigation and forwarded to Ford for interpretation. The frontal air bags deployed and the driver's pre-tensioner fired as a result of the frontal impact sequence with the right front side of the Mercury Tracer (**Figure 10**).



Figure 10. Overall view of the deployed frontal air bags in the Ford Taurus.

The driver air bag was housed in a conventional configuration within the 4-spoke steering wheel rim. The H-configuration module cover flaps were symmetrical in shape and opened at the designated tear points. Both flaps were 16.5 cm (6.5") in width at the horizontal tear seam. The vertical dimensions of the upper and lower flaps were 7.0 cm (2.75") and 4.4 cm (1.75") respectively. The driver air bag membrane was approximately 55.9 cm (22.0") in diameter in its deflated state and was vented by two 2.5 cm (1.0") diameter ports located at the 10 and 02 o'clock sectors on the back side of the bag (opposite driver). The

bag was tethered by four internal straps sewn to the face of the bag with a (6.0") diameter reinforcement. There was no contact evidence on the driver air bag, however, blood spatters were noted to the top of the membrane from the front right passenger.

The front right passenger air bag deployed from a single cover flap module from the upper right instrument panel. The width of the flap was 27.7 cm (10.9") while the height of the flap was 8.9 cm (3.5") at the right side. The passenger air bag membrane was 58.4 cm (23.0") in width and 50.8 cm (20.0") in height. The bag was vented by two 4.4 cm (1.75") diameter ports located on the lateral aspects of the bag at the 3 and 9 o'clock sectors.

The front right passenger loaded the deployed air bag and deflected the bag into the windshield. Although there was no evidence of occupant contact to the bag, membrane transfers were noted to the laminated glazing. Blood was also present on the bag, however, this resulted post-crash prior to the passenger exiting the vehicle.

The driver was restrained by the manual belt system, therefore the pre-tensioner was armed and fired during the crash (**Figure 11**). The post-crash length of the barrel was 67.3 mm (2.625"). This equated to a piston travel distance of 42.7 mm (1.68"). The driver's pre-tensioner was identified by the bar coded label number F2B914701261527.



Figure 11. Buckle pre-tensioners.

The front right passenger of the Ford Taurus was not restrained by the manual belt system. Therefore, the buckle switch was not engaged and the pre-tensioner did not fire. The front right pre-tensioner was identified by the bar coded number F2B914601261677.

Event Data Recorder Output

The data from the Ford Taurus' Restraints Control Module (RCM) was provided to the Veridian SCI team. The data confirmed the findings of the field investigation that the driver was belted and the front right passenger of the Taurus was unbelted. In addition, the RCM recorded that the driver's seat track was not adjusted to a forward position. The time frame from algorithm wake-up to pre-tensioner firing was 11 milliseconds and the time frame from algorithm wake-up to first stage driver and passenger air bag deployment was also 11 milliseconds. The second stage was disposed by design at an unrecorded time frame of approximately 100 milliseconds following the first stage deployment.

The EDR recorded a longitudinal delta V of -31.7 km/h (-19.7 mph) and a lateral component of 18.6 km/h (11.6 mph) at the 78 millisecond recording interval.

The data charts are attached as Attachment A of this summary report.

Occupant Demographics

2000 Ford Taurus

Driver: 40 year old male
Height: 193 cm (76")
Weight: 113.4 kg (250.0 lb)
Manual Restraint
Usage: 3-point lap and shoulder belt system
Usage Source: Vehicle inspection, pre-tensioner firing
Seat Position: Full rear with 30 degree recline of seat back support
Eyewear: None
Mode of Transport
From Scene: Transported by ambulance to a local hospital to accompany the front right passenger
Type of Medical Treatment: Refused treatment

Driver Injuries

Injury	Injury Severity (AIS Update 98)	Injury Mechanism
Several small lacerations on inside surface of the left index finger	Minor (790600.1,2)	Not crash related, contacted door glass as he exited vehicle
Soreness of the chest, posterior neck, and both arms	N/A, not codeable under AIS rules	Shoulder belt webbing and bracing against the steering wheel rim

**Source - Driver Interview*

Driver Kinematics

The driver of the Ford Taurus was seated in a full rear track position with the seat back reclined to an angle of 30 degrees. The bottom of the head restraint was adjusted 4.1 cm (1.6") above the top of the seat back. He was properly restrained by the manual 3-point lap and shoulder belt system. Belt usage was verified by the lack of occupant contact points within the vehicle and the firing of the buckle pre-tensioner. There was no loading evidence on the beige belt webbing or visible evidence on the plastic surfaces of the latch plate or D-ring. The adjustable D-ring was positioned 2.3 cm (0.9") below the top adjustment point. Immediately prior to the crash event, the driver was seated in an upright posture with both hands bracing against the steering wheel rim at the 3 and 9 o'clock positions. His right foot firmly applied the brake pedal as he braked the ABS equipped vehicle in an attempt to avoid the crash. The Taurus was equipped with adjustable foot pedals. These pedals were adjusted to the full forward position; most distant from the driver.

At impact with the Tracer, the Taurus' frontal air bag system deployed and the driver's buckle pretensioner fired. The driver initiated a forward trajectory and loaded the manual belt webbing as he braced against the steering wheel rim and the brake pedal. His bracing/loading force against the steering wheel contributed to the compression of the energy absorbing steering column. The left shear bracket was separated 1.6 cm (0.625") while the right unit remained fully engaged. The inboard edge of the cast U-bracket for the right shear fractured. There was no bending of the steering wheel rim, however, the mounting flange was deformed from its alignment with the column. It should be noted the front right passenger also loaded the right edge of the steering wheel rim which possibly contributed to the compression and deflection of the steering components. As a result of loading the manual belt system and bracing against the steering wheel, the driver sustained soreness of the chest and both arms with no visible injury. In addition, he complained of soreness of the posterior neck from probable flexion of the head as he loaded the manual belt webbing.

The driver's braking and subsequent loading force against the adjustable brake pedal deflected the right side of the pedal pad forward (**Figure 12**). Due to his rear and reclined seated position, the driver probably minimally loaded the deployed redesigned driver air bag. The combination of manual and automatic restraint systems provided the driver with maximum crash protection and prevented him from contact with interior components. It should be noted that there was no loading evidence on the knee bolster.



Figure 12. Deflection of the adjustable brake pedal.

Immediately following the crash, the driver attempted to open the left front door, however, the door failed to open from the interior. He observed a smoke-like substance within the vehicle from deployment of the frontal air bag system. He immediately unbuckled his manual belt system and crawled out of the vehicle through the left rear door window opening. The glazing was shattered by the subsequent sideslap. During his exit from the vehicle, the driver sustained several minor lacerations of the left index finger from contact with fragments of the tempered glass.

Once outside the vehicle, he attempted and successfully opened the left front door and instructed the front right passenger to exit the vehicle from this door. At this point he waited for emergency personnel to arrive on-scene.

The driver was transported by ambulance to a local hospital to accompany the front right passenger for treatment. He refused medical treatment as the finger lacerations did not require sutures.

Front Right Passenger Demographics

Age/Sex: 60 year old female
 Height: 160 cm (63")
 Weight: 90.7 kg (200 lb)
 Manual Restraint
 Usage: None, 3-point lap and shoulder belt was available
 Usage Source: Vehicle inspection, non-fire of the buckle pre-tensioner
 Eyeware: None
 Mode of Transport
 From Scene: Transported by ambulance to a local hospital
 Type of Medical
 Treatment: Treated for her injuries and released

Front Right Passenger Injuries

Injury	Injury Severity (AIS Update 98)	Injury Mechanism
10 cm (4") laceration of the left temporal and parietal scalp	Minor (190602.1,2)	Inboard pivot/clip of the driver's side sun visor
Left rib contusion	Minor (450202.1,2)	Right edge of the steering wheel rim
Multiple abrasions over the right knee	Minor (890202.1,1)	Glove box door
Contusion with swelling of the right knee	Minor (890402.1,1)	Glove box door
Left knee contusion	Minor (890402.1,2)	Lower mid instrument panel
Swelling of the right ankle	N/A, not codeable under AIS	Right floor pan

* Source - Interview

Front Right Passenger Kinematics

The front right passenger of the Taurus was a 60 year old female with a stated height of 160 cm (63") and weight of 91 kg (200 lb). She was not restrained by the manual belt system. The lack of belt usage was determined by the non-fire status of the pre-tensioner and the contact evidence within the vehicle from this passenger. At the initial impact with the Tracer, the unrestrained passenger initiated a trajectory that was forward and to her left (**Figure 13**). She loaded the deployed front right air bag and deflected the air bag into the windshield as evidenced by a membrane fabric transfer was to the windshield. Her knees loaded the glove box door and the side aspect of the center lower instrument panel. A large black fabric transfer was noted to the left side of the glove box door. The passenger's right knee was abraded with swelling from the contact sequence. Her face and torso probably contacted the deployed front right passenger air bag. There was no contact evidence on the air bag membrane.



Figure 13. Trajectory of the unrestrained front right passenger of the Taurus.

As the Taurus was deflected in a clockwise direction, the passenger continued to her left. This trajectory was accelerated by the subsequent left side sideslap impact sequence. The right shoulder of the passenger probably contacted the rear view mirror, displacing the mirror downward from its adjusted position. Her left chest area impacted the right edge of the steering wheel rim, displacing the wheel to the left. She sustained a left rib contusion as a result of the contact sequence. Her left temporal scalp contacted the inboard hinge point of the driver's sun visor which produced a 10 cm (4") laceration of the scalp. Hair and tissue evidenced the contact point (**Figure 14**).

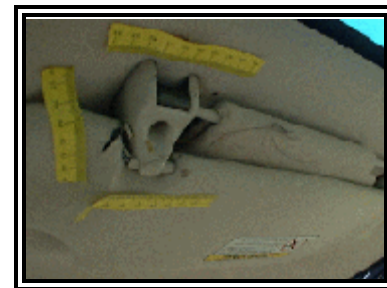


Figure 14. Passenger's head impact to the sun visor bracket.

The passenger came to rest against the steering wheel in front of the driver. She bled onto the front left air bag then slid back to the front right position where she bled onto the front right passenger air bag. She subsequently exited the vehicle through the left front door as it was opened by the driver following his exit from the vehicle. The passenger immediately sat sideways on the left front seat and waited for emergency personnel to arrive on-scene. She was transported to a local hospital where she was treated for her injuries and released.

Occupant Demographics/Injury

Mercury Tracer

Driver: 38 year old female
Height: 160 cm (63")
Weight: 54.4 kg (120.0 lb)
Restraint Usage: 2-point motorized shoulder belt, no manual lap belt
Usage Source: Vehicle inspection, driver injury
Mode of Transport
From Scene: Ambulance
Type of Medical
Treatment: Transported to a local trauma center where she expired approximately 4 hours post-crash

Driver Injuries

Injury	Injury Severity (AIS Update 98)	Injury Mechanism
Grade V liver laceration of the right lobe	Critical (541828.5,1)	Motorized shoulder belt webbing
Left hemothorax	Serious (442202.3,2)	Motorized shoulder belt webbing
Abrasion of the right lower abdomen	Minor (590202.1,1)	Motorized shoulder belt webbing

* Source - CIREN case study

Driver Kinematics

The driver of the Tracer was a 38 year old female. She was restrained by the automatic 2-point shoulder belt system, however, she was not wearing the manual lap belt. The driver initiated a lateral and forward trajectory to her right at impact. She loaded the motorized shoulder belt webbing which produced an abrasion to the right lower abdominal wall. As she engaged the webbing, her pelvic region moved out of her seated position which allowed her torso to submarine the shoulder belt webbing. As a result, the driver sustained a Grade V laceration of the right lobe of the liver and a left hemothorax.

The driver exited the vehicle at the scene and was found lying outside the vehicle. She was transported by ambulance to a local trauma center where her condition deteriorated. She was rushed to surgery where she expired approximately four hours following the crash.

Passengers of the Mercury Tracer

The center rear position of the Tracer was occupied by a 4 year old child passenger who was restrained in an older model Renolux forward facing child safety seat (CSS). The CSS was identified by Nos.

BTPDSE.90.144. This CSS was recalled for multiple issues and was removed from the market. The CSS was equipped with an integral 5-point harness and a swivel base. The base provided lateral positioning of the CSS. The safety seat was secured to the vehicle the center rear lap belt, however, the belt was loosely applied through the belt path (**Figure 15**). This allowed for approximately 30 degrees of lateral rotation in both directions. The child was reportedly secured in the safety seat by the integral 5-point harness system. The child sustained police reported minor injuries.



Figure 15. Improperly installed child safety seat.

The right rear passenger of the Tracer was a 68 year old female. She was not restrained by the manual 3-point belt system. The passenger sustained no visible injuries, but complained of pain to the investigating officer.

VERIDIAN CRASH SCHEMATIC
CASE NO. CA00-059

Vehicle #1 - 2000 Ford Taurus
Vehicle #2 - 1993 Mercury Tracer
Vehicle #3 - 1999 Hyundai Elantra

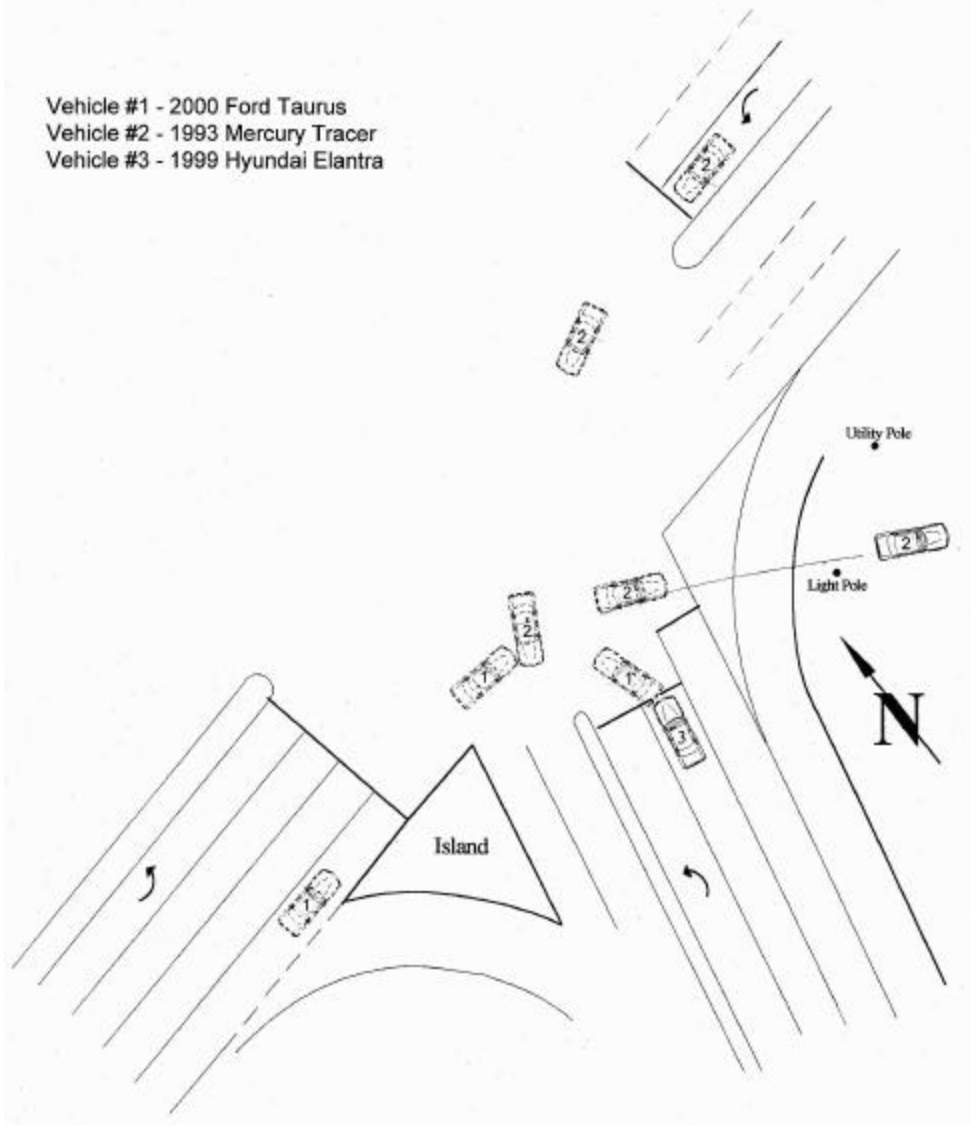


Figure 16. Crash schematic

Attachment A

2000 Taurus/Sable EDR Report - Summary Page

Investigation Data

File Name:	CA00-059.hex	File Save Date:	10-Jan-2001
File Read-out Date:	N/A	Report Date:	29-Jan-2001
Report Version:	1.6		

EDR Control Module Data

Data Validity Check:	Valid	EDR Model Version:	141
Time From Side Safing Decision to Left (Driver) Side Bag Deployment:			Not Deployed
Time From Side Safing Decision to Right (Passenger) Side Bag Deployment:			Not Deployed
Passenger Airbag Switch Position During Event:			N/A
Diagnostic Codes Active When Event Occurred:			0

Algorithm Times

Actual initiation depends on restraint system status (below).

	ms
Time From Algorithm Wakeup to Pretensioner:	11
Time From Algorithm Wakeup to First Stage - Unbelted:	11
Time From Algorithm Wakeup to First Stage - Belted:	11
Time From Algorithm Wakeup to Second Stage:	0

Restraint System Status

Driver Seat Belt Buckle:	Engaged
Passenger Seat Belt Buckle:	Not Engaged
Driver Seat Track In Forward Position:	No
Passenger Seat Weight Switch Position:	N/A

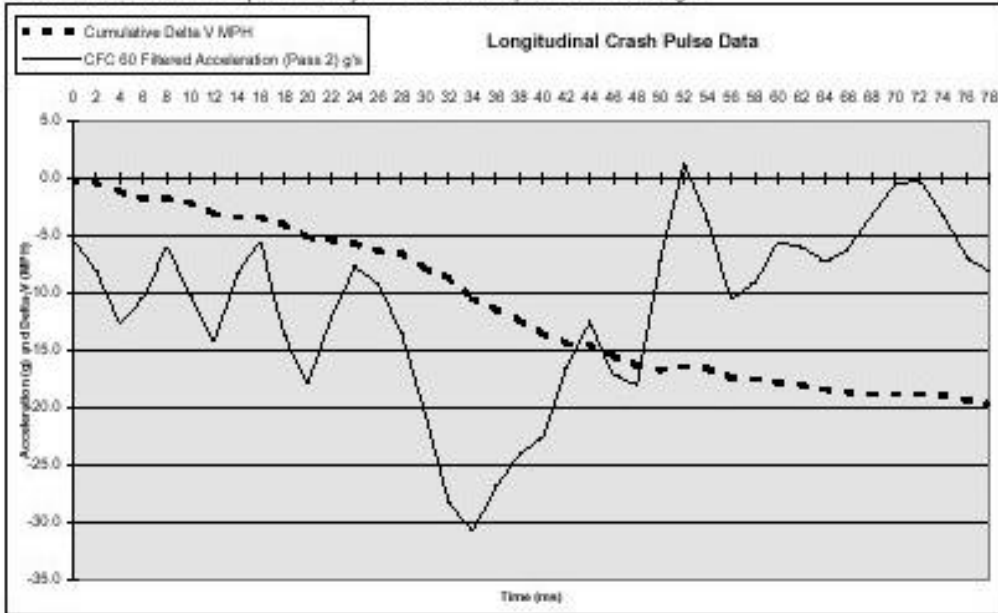
Deployment Initiation Attempt Times

	Driver	Passenger
Time From Algorithm Wakeup to Pretensioner Deployment Attempt:	11	Unbelted
Time From Algorithm Wakeup to First Stage Deployment Attempt:	11	11
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Disposal	Disposal

Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	-0.1	-2.1	-5.1	-7.9	-11.0	-14.9	-17.9	-18.9	-19.1

Note: Acceleration data and plots are only valid for frontal impact event recordings.



Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.1	0.2	0.9	1.6	1.9	4.6	8.2	10.9	11.6

Note: Acceleration data and plots are only valid for frontal impact event recordings.

