

**TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION**

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**ADVANCED OCCUPANT PROTECTION SYSTEM STUDY
2000 FORD TAURUS INVESTIGATION**

VERIDIAN CASE NO. CA00-019

LOCATION - TENNESSEE

CRASH DATE - JUNE 2000

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The crash investigation process is an inexact science which requires that physical evidence such as skid marks, vehicular damage measurements, and occupant contact points be 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 of the involved vehicle(s) or their safety systems.

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<p>17. <i>Abstract</i></p> <p>This on-site investigation focused on the performance of the redesigned occupant protection system in the 2000 Ford Taurus. The occupant protection system was a total redesign from earlier model years. The protection system consisted of an integrated use of 3-point lap and shoulder belts, pre-tensioners, seat position sensing and dual-stage air bag inflation. The driver and front right passenger air bags were designed to deploy at different thresholds of crash severity dependant on restraint use and seat position. The subject 2000 Ford Taurus was involved in a single vehicle roadside departure with subsequent impacts to a mailbox and utility pole. The severity of the crash was below the threshold to deploy the vehicle's frontal air bags. The unrestrained 86 year old male driver was the vehicle's sole occupant. He suffered multiple right rib fractures, a lumbar compression fracture, facial fractures and multiple abrasions as a result of the impact. He died eight days post-crash.</p> <p>This crash was identified by National Automotive Sampling System PSU 45 during the weekly poll of the region's police agencies. The crash report was forwarded to the Special Crash Investigations team at Veridian Engineering and the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA). NHTSA subsequently assigned an on-site crash investigation as part of the Advanced Occupant Protection System Study. Specifically, the SCI team was assigned the task of inspecting the Ford Taurus and downloading the crash data stored in the vehicle's Restraint Control Module to supplement the crash analysis</p>			
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**ADVANCED OCCUPANT PROTECTION SYSTEM STUDY
2000 FORD TAURUS**

**VERIDIAN CASE NO: CA00-019
LOCATION: TENNESSEE
CRASH DATE: JUNE, 2000**

BACKGROUND

This on-site investigation focused on the performance of the redesigned occupant protection system in the 2000 Ford Taurus. The occupant protection system was a total redesign from earlier model years. The protection system consisted of an integrated use of 3-point lap and shoulder belts, pre-tensioners, seat position sensing and dual-stage air bag inflation. The driver and front right passenger air bags were designed to deploy at different thresholds of crash severity dependant on restraint use and seat position. The subject 2000 Ford Taurus was involved in a single vehicle roadside departure with subsequent impacts to a mailbox and utility pole. The severity of the crash was below the threshold to deploy the vehicle's frontal air bags. The unrestrained 86 year old male driver was the vehicle's sole occupant. He suffered multiple right rib fractures, a lumbar compression fracture, facial fractures and multiple abrasions as a result of the impact. He died eight days post-crash.

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SUMMARY

Crash Site

This single vehicle crash occurred during the afternoon hours of June, 2000. It was daylight at the time of the crash and the weather was not a factor. The road surface was dry. At the scene, the roadway was predominately north/south in direction and was configured with two asphalt lanes. There was a 114 m (375 ft) radius left curve for northbound traffic. The northbound grade measured -3%. Private residences bordered both sides of the road. At the curve's apex, the east (right) road shoulder was asphalt and measured 1.3 m (4.2 ft). The shoulder changed to gravel and then tapered to grass. A gravel driveway with an asphalt apron intersected from the east and was located immediately prior to the point of impact. Two mailboxes and two utility poles were located north of the driveway apron and approximately 3 m (10 ft) east of the fog line. **Figure 1** is a trajectory view of the Ford Taurus approximately 30 m (100 ft) south of the utility poles. **Figure 2** is a view of the point of impact.



Figure 1: Trajectory view of the Ford.



Figure 2: Point of impact.

Pre-Crash

The 2000 Ford Taurus was driven by an 86 year old male driver. The driver had a reported height and weight of 180 cm (71 in) and 68 kg (150 lb) and was in poor health. He was unrestrained and seated in a probable mid-to-rear seat track position considering his stature. He was the sole occupant of the vehicle. The Ford was northbound approaching the left curve at the crash scene.

Crash

Figure 3 is a schematic of the crash. For unknown reasons, the driver failed to negotiate the left curve and drifted off the right side of the road. The Ford traveled across the driveway apron, at the curve's apex, and struck the mailboxes and utility poles north of the driveway. The impact sheared the mailbox support posts at the ground level. The mail boxes then stuck the hood and fractured the windshield. The right front fender of the Taurus first contacted the utility poles in swiping contact. This contact began immediately forward of the right front axle. As the Taurus continued its northeastward trajectory, the vehicle's engagement with the pole increased. The Principle Direction of Force during this impact was in the 1 to 2 o'clock sector at maximum engagement. The frontal air bags did not deploy in the crash. The Taurus's contact with the utility pole continued to the area of the C-pillar. After disengagement from the pole, the Taurus continued northeastward into the front yard of a private residence. The home owner

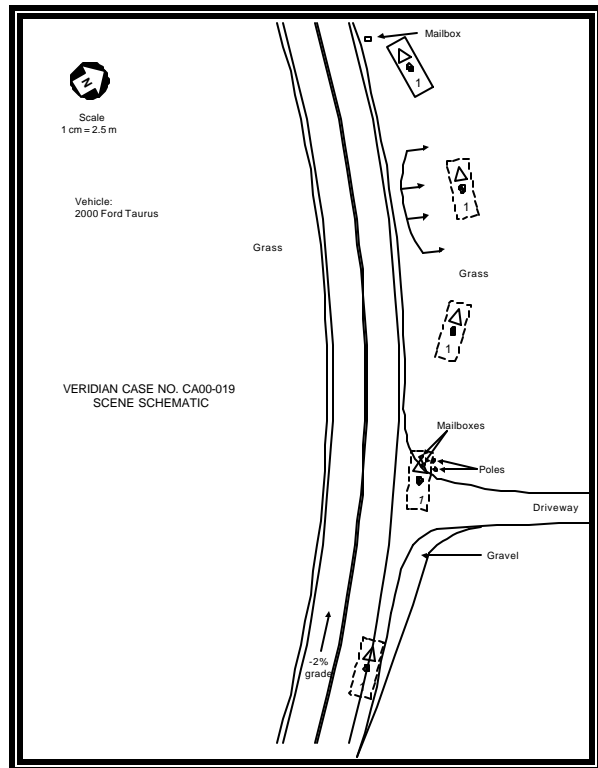


Figure 3: Crash schematic.

indicated the vehicle came to rest facing northward approximately 37 m (120 ft) north of the point of impact.

Post-Crash

The police and ambulance responded to the crash scene. The driver was found unconscious on the passenger side of the vehicle. He was removed, transported to a level 1 trauma center and admitted into the intensive care unit. His Glasgow Coma Scale (GCS) upon admission was 15. He tested positive for alcohol (BAC unknown). He sustained multiple trauma in the crash that included: multiple right rib fractures with pneumothorax, facial fractures and a compression fracture of the lumbar spine. He suffered a myocardial infarction two days post-crash and his condition continued to deteriorate. He was eventually listed as Do Not Resuscitate (DNR) by his family. He died eight days post-crash due to respiratory arrest.

Reportedly during the two years preceding the crash, the driver's wife had passed away and he had become depressed. His family had become worried about him. Additionally, the medical records noted an alcohol problem that had worsened during that interval.

2000 FORD TAURUS

The 2000 Ford Taurus Station Wagon was identified by the Vehicle Identification Number (VIN): 1FAFP58S1YA (production sequence deleted). The vehicle's power train consisted of a 3.0 liter, V-6 engine linked to a 4-speed automatic transmission. The vehicle had 4-wheel discs brakes. It was not ABS equipped. The interior was equipped with a power package that included power steering, brakes windows, door locks, and mirrors. The vehicle also had adjustable foot controls and a 6-way power driver seat. The vehicle was manufactured in April 2000. The odometer read 958 km (595 miles) at inspection.

Exterior Damage

Figure 4 is a front view of the Ford Taurus. The front plane sustained 18 cm (7 in) of direct contact damage as a result of the mailbox impact. The direct contact began 1.3 cm (0.5 in) left of center and extended to the right. There was no measurable bumper crush as a result of the impact. The mailbox then contacted the hood approximately 5 cm (2 in) left of center and 30 cm (12 in) rearward of the its leading edge. This contact was identified by a yellow paint transfer. The mailbox then struck and fractured the lower aspect of the windshield. The windshield fracture was located approximately on the vehicle's center line. The Collision Deformation Classification (CDC) of this



Figure 4: Front view of the Taurus.

impact was 12-FCEN-01.

The right side plane sustained a 305 cm (120 in) of combined direct and induced damage that began 33 cm (13 in) forward of the right front axle, **Figure 5**. The direct contact with the utility poles was sideswiping in nature, rather than direct impact. The crash pulse had a long duration with a (relatively) low magnitude of deceleration. The direct contact damage began 13 cm (5 in) forward of the right front axle and extended rearward 284 cm (112 in). The (direct and induced) damage ended 3.8 cm (1.5 in) forward of the right rear axle. The crush profile measured along the trim elevation measured as follows: C1=0, C2=17.3 cm (6.8 in), C3=29.2 cm (11.5 in), C4=16.5 cm (6.5 in), C5=3.8 cm (1.5 in), C6=0. Maximum crush occurred at C3 and was located approximately 5 cm (2 in) forward of the B-pillar. Contact with the poles buckled the exterior panels of the right doors and displaced them from the vehicle. The right windows disintegrated on impact and the right aspect of the windshield was fractured. There was no measurable change in the wheelbase dimension. The CDC was 01-RYAW-03. The total delta V calculated by the Barrier Algorithm of the WINSMASH model was 25.7 km/h (16 mph). The longitudinal and lateral components were -19.6 km/h (-12.2 mph) and -16.6 km/h (-10.3 mph), respectively.

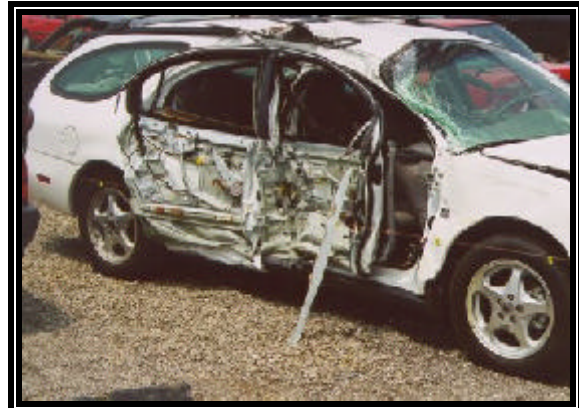


Figure 5: Right front view.

Occupant Protection System

The occupant protection system in the 2000 Ford Taurus, designated by the manufacturer as the Personal Protection System (PPS), was a total redesign from earlier model years. The protection system consisted of the integrated use of manual 3-point lap and shoulder belts, pre-tensioners, seat position sensing and dual-stage air bag inflation. The driver and front right passenger air bags were designed to deploy at different thresholds of crash severity dependant on restraint use and seat position. The Restraint Control Module (RCM) located on the vehicle's centerline under the instrument panel monitored and controlled the deployment of the vehicle's safety systems. The RCM was capable of recording data related to the crash event.

The crash event data stored in the RCM was downloaded in the field during the SCI inspection. This data was then sent to the Safety Office of the Ford Motor Company for analysis. The results of the downloaded data are included as **Attachment A**, at the end of this report. The data indicated the left restraint was not buckled. Neither the buckle pretensioner nor the frontal air bags were deployed. The 78 millisecond longitudinal delta V measured -8.8km/h (-5.5 mph). The 78 millisecond lateral delta V was -7.7 km/h (-4.8 mph) and still rising. It should be noted that this was not the total delta V of the impact, only the recorded delta V at the 78 millisecond interval.

Figures 6 and 7 are views of the front interior. The electrically adjustable driver's seat was adjusted to a mid-to-rear position and measured 20 cm (8 in) rear of full forward. The electrical system was intact and the vehicle had been driven, therefore it could not be verified if this was the at-crash position. The foot controls were adjustable and in the full rear position.



Figure 6: Interior view of the driver's position.



Figure 7: View of center and right interior.

The vehicle was equipped with 3-point lap and shoulder belt systems in the front outboard seat positions. The front seat belt systems consisted of a continuous loop lap and shoulder belt webbing with a sliding latch plate. The vehicle sensitive/energy management retractors were located in the base of the B-pillars. The front restraints were also equipped with buckle mounted pretensioners. The driver's pretensioner did not fire as a result of the crash. The post-crash measurement of the pretensioner's barrel was 11 cm (4.3 in). Upon inspection, the driver's restraint webbing was stowed in the retractor and operational. Inspection of the latch plate identified some minor evidence of historical use. Inspection of the webbing and belt system did not reveal any evidence of loading during the crash. The driver was not restrained by the belt system during the crash event.

There was no intrusion or interior damage related to the exterior forces of the crash. The driver knee bolster was not damaged. A single scuff mark from probable right knee contact was identified on the left aspect of the lower central instrumental panel, refer to **Figure 6**. The area measured approximately 5 cm x 5 cm (2 in x 2 in). It was located 15 cm (6 in) left of the vehicle's center line and 30 cm (12 in) below the top of the instrument panel. The center mirror was displaced down and right from probable head contact. The center console was down and exhibited indications of contact from the driver's right hip. There was no other evidence of occupant contact on the vehicle's interior surfaces.

The steering wheel rim angle was adjustable and found in the full-up position. There was no rim deformation and the steering column showed no signs of loading. There was no movement of the shear capsules and the bend bracket was undeformed. The shear plate on the lower aspect of the column was intact.

The driver air bag was located in the typical configuration in the center hub of the steering wheel. The front right air bag was a top-mount design located in the right aspect of the instrument panel. Neither air bag had deployed in the crash.

DRIVER DEMOGRAPHICS

Age/Sex: 86 year old/ Male
 Height: 180 cm (71 in)
 Weight: 68 kg (150 lb)
 Restraint Use: Unrestrained
 Usage Source: SCI inspection, Occupant Kinematics, RCM
 Medical treatment: Admitted to the intensive care unit
 Outcome: Died 8 days post-crash

DRIVER INJURIES

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Right 2-8 ribs fractured w/ pneumothorax	Severe (450232.4,1)	Center instrument panel
Compression fracture of the lumbar spine - L3/4, NFS	Moderate (650630.2,8)	Center console
Right maxillary fracture	Moderate (250800.2,1)	Center instrument panel
Right lateral orbit fracture	Moderate (251200.2,1)	Center instrument panel
Undiagnosed Closed Head Injury - Loss of consciousness at scene, amnesic to events of crash, GCS=15 on admission	Moderate (160410.2,0)	Center instrument panel
Abrasion - right temple	Minor (190202.1,1)	Center mirror
Abrasion - right cheek	Minor (290202.1,1)	Center instrument panel
Abrasion - right elbow	Minor (790202.1,1)	Center console

Note: The above injuries were identified in the treating hospital's discharge summary and diagnostic test records.

OCCUPANT KINEMATICS

Immediately prior to the crash, the driver failed to maintain the travel lane and/or relinquished directional control of the Ford Taurus due to probable alcohol impairment. The position of the driver's seat could not be verified, however based on the driver's stature, it was probably adjusted in a mid-to-rear track position. His injuries suggest he had an upright in the driver's seat. He was not restrained by the vehicle's 3-point lap and shoulder belt.

The initial impact with the mailbox sheared the wooden support post and had minimal effects on the driver's kinematics. Upon impact with the utility poles, the driver responded to the 2 o'clock direction of force by moving to the right and forward. The driver's right hip and lower extremity contacted the center console and mid panel, respectively. The hip contact (indirectly) resulted in the lumbar compression fracture. The right aspect of driver's chest contacted the center instrument panel resulting in the multiple right rib fractures and pneumothorax. His head contacted the center mirror deflecting it down and resulted in the right temple abrasion. The inertia of the head and neck complex then caused the neck to flex forward and down. The driver's right cheek impacted the instrument panel resulting in the right maxillary and orbit fractures and loss of consciousness. The driver then fell toward the right side of the vehicle where he was found.

ATTACHMENT A:

2000 Taurus/Sable EDR Report - Summary Page



Investigation Data

File Name:	CA00019.hex	File Save Date:	17-Jul-2000
File Read-out Date:	N/A	Report Date:	17-Jul-2000
Report Version:	1.2		

EDR Control Module Data

Data Validity Check:	Valid	EDR Model Version:	141
Left (Driver) Side Bag Deployment Time (ms):			Not Deployed
Right (Passenger) Side Bag Deployment Time (ms):			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:	0
Time From Algorithm Wakeup to First Stage - Unbelted:	0
Time From Algorithm Wakeup to First Stage - Belted:	0
Time From Algorithm Wakeup to Second Stage:	0

Restraint System Status

Driver Seat Belt Buckle:	Not 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:	Not Deployed	Not Deployed
Time From Algorithm Wakeup to First Stage Deployment Attempt:	Not Deployed	Not Deployed
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Not Deployed	Not Deployed

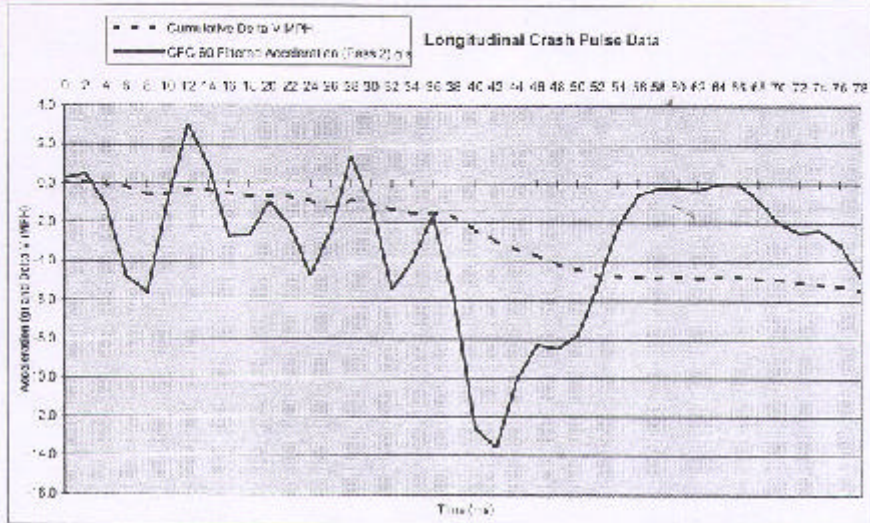
Notes

1. Read-out date is set by the PC Interface tool.
2. Features and data parameters which are not available on the module are marked 'N/A'.
3. CRC 50 is a Bunkerwerk 4-pole phaseless digital filter. (See SAE J211, Part 1 Appendix C dated March 1996.)
4. Total and maximum Delta V results are not available from truncated/incomplete crash pulses.
5. Algorithm wakeup (0 ms) is not the first moment of vehicle contact or impact.
6. The Excel 'Analysis ToolPak' Add-in must be enabled for this spreadsheet to operate properly.

2000 Taurus/Sable EDR Report - Charts

Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	2.1	0.5	-0.6	-1.5	-2.5	-4.4	-4.9	-4.9	-5.5



Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.0	1.0	-0.3	-1.2	-2.5	-3.8	-4.5	-4.5	-4.5

