TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER

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ADVANCED OCCUPANT PROTECTION SYSTEM STUDY
2000 FORD TAURUS INVESTIGATION

VERIDIAN CASE NO. CA00-038

LOCATION - MICHIGAN

CRASH DATE - SEPTEMBER 2000

Contract No. DTNH22-94-07058

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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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17. *Abstract*

This on-site investigation focused on the performance of the advanced occupant protection system in the 2000 Ford Taurus that included redesigned frontal air bags. The advanced occupant protection system consisted of force limited 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 dependent on restraint use and seat position. The subject 2000 Ford Taurus was the striking vehicle in a front-to-rear chain reaction crash that involved a 2000 Land Rover Discovery II and a 1998Nissan Pathfinder. The frontal air bags in the Ford Taurus did not deploy in the crash. The 46 year old male driver was the sole occupant of the Taurus and post-crash had a police reported complaint of pain. He denied medical attention.

This crash was identified through the weekly sampling of police agency crash reports conducted by the General Estimates System (GES). This crash report was forwarded to the Special Crash Investigations team at Veridian Engineering on October 2, 2000. The Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA) was informed of the crash by the Veridian SCI team and was subsequently assigned the task of inspecting the subject vehicle as part of the Advanced Occupant Protection System Study. The SCI team was specifically assigned the task of downloading the crash data stored in the vehicle's Restraint Control Module (RCM).

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ADVANCED OCCUPANT PROTECTION SYSTEM STUDY
2000 FORD TAURUS
VERIDIAN CASE NO: CA00-038

LOCATION: MICHIGAN
CRASH DATE: SEPTEMBER, 2000

BACKGROUND

This on-site investigation focused on the performance of the advanced occupant protection system in the 2000 Ford Taurus that included redesigned frontal air bags. The advanced occupant protection system consisted of force limited 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 dependent on restraint use and seat position. The subject 2000 Ford Taurus was the striking vehicle in a front-to-rear chain reaction crash that involved a 2000 Land Rover Discovery II and a 1998Nissan Pathfinder. The frontal air bags in the Ford Taurus did not deploy in the crash. The 46 year old male driver was the sole occupant of the Taurus and post-crash had a police reported complaint of pain. He denied medical attention.

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SUMMARY

Crash Site

This three-vehicle crash occurred in the evening hours of September, 2000. It was daylight at the time of the crash and the weather was not a factor. The road surface was dry. At the crash scene, the primary roadway was configured with two lanes, east/west in direction, **Figure 1**. A two lane north/south road intersected from the south forming a 3-leg intersection. The intersection was controlled by a stop sign for northbound traffic. Approximately 400 m (1/4 mile) east of the intersection, the primary roadway intersected a four lane divided highway. This intersection caused a back-up in traffic at the time of the crash. The speed limit in the area of the crash was 64 km/h (40 mph).

Figure 1: Eastward view of the crash scene.

Pre-Crash

The 1998 Nissan Pathfinder was eastbound driven by a 38 year old restrained male. The Nissan was traveling within a string of traffic. A 2000 Land Rover Discovery II, traveling behind the Nissan, was driven by a 28 year old restrained female. The 2000 Ford Taurus was driven by a 46 year old male and was the trailing vehicle.

The driver of the Nissan Pathfinder braked the vehicle and slowed for stopped traffic. In response, the driver of the Land Rover also braked. The driver of the Ford Taurus failed to recognize the slowing traffic and braked the Taurus too late to avoid the crash.

Crash

The crash occurred with the front plane of the Taurus striking and under-riding the back plane of the Land Rover in a 12/6 o'clock impact configuration. The momentum of the striking Ford then displaced the Land Rover into a secondary front-to-rear collision with the Nissan. The vehicles came to rest in-line with each other near the point of impact. The force of the below threshold collision did not command deployment of the advanced safety systems in the Ford Taurus. **Figure 2** is the police schematic of the crash.

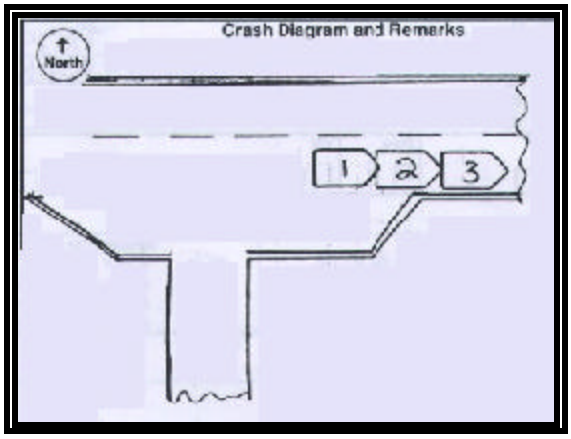


Figure 2: Police crash schematic.

Post-Crash

The respective drivers exited their vehicles under their own power prior to the arrival of the investigating police officer. No one was injured and medical transport was not required. The Ford Taurus and Land Rover sustained disabling damage and were towed from the scene. The Nissan drove from the scene under its own power. All the drivers reported to the officer they were restrained at the time of the crash. However, contrary to the police crash report, the SCI investigation has determined the Taurus driver was not restrained.

2000 FORD TAURUS

The 2000 Ford Taurus was identified by the Vehicle Identification Number (VIN): 1FAFP5520YG (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 4-door sedan was manufactured in February 2000. The odometer read 27,612 km (17,158 miles) at the time of the inspection. The vehicle was owned by an automobile rental agency. It was being operated under a rental agreement at the time of the crash.

Exterior Damage

The front plane of the Ford Taurus sustained 157 cm (62 in) of direct contact damage that extended across the vehicle's full frontal width, **Figures 3 and 4**. This damage pattern was above the level of the front bumper and was consistent with the dynamics of a braking vehicle and an under-ride type impact. There

was minimal direct bumper to bumper contact. The only damage to the front bumper system were longitudinal scratches to the top (horizontal) surface of the fascia. The direct damage consisted of deformation to the hood and structures within the engine compartment. The vehicle's electrical system was intact. The crush profile measured across the upper radiator support was as follows: C1=0, C2=4.4 cm (1.8 in), C3=16.5 cm (6.5 in), C4=14.0 cm (5.5 in), C5=5.0 cm (2.0 in), C6=0. The maximum crush was 19.0 cm (7.5 in) and was located 11.4 cm (4.5 in) left of the vehicle's centerline. The contact damage on the surface of the hood extended rearward 79 cm (31 in) from the front of the Taurus. There was no change in the vehicle's wheelbase dimensions. The operation of the right front door was restricted by the rearward displacement of the right fender. The remaining doors were operational. The Collision Deformation Classification (CDC) was 12-FDEW-01. The Damage Only Algorithm of the WINSMASH model calculated a total delta V of 13.8 km/h (8.6 mph) for the Taurus in this impact. The longitudinal and lateral components were -13.8 km/h (-8.6 mph) and 0 km/h, respectively. The calculated Barrier Equivalent Speed was 13.8 km/h (8.6 mph). The results of the WINSMASH reconstruction appeared reasonable.

Figure 3: Left front view of the Taurus damage.

Figure 4: View of the damaged front plane.

Advanced Occupant Protection System

The advanced 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 manual 3-point lap and shoulder belts with load limiting retractors, buckle 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 dependent 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 data was downloaded in the field during the SCI inspection. This data was then electronically forwarded to the Safety Office of the Ford Motor Company for analysis. The results of the downloaded data are included as **Attachment A**. The data indicated the left front belt system was not buckled and there

was no command to deploy the pre-tensioners or air bags. Also there were no diagnostic fault codes present when the crash occurred. The 78 millisecond longitudinal delta V was approximately 13.7 km/h (8.5 mph) and appeared to have reached a plateau. It should be noted that this was not the total delta V of the impact, only the recorded delta V at that time interval. The typical duration of a vehicle-to-vehicle impact of this nature is greater than 78 milliseconds.

Figure 5 is a left interior view of the front occupant compartment. The electrically adjustable driver's seat was adjusted in a mid-to-rear position at inspection that measured 18.8 cm (7.4 in) rear of full forward. The total seat track travel was 25 cm (10 in). It was not verified that this was the at-crash track position, as the vehicle was still operable and probably driven prior to storage.

Figure 5: Left interior view.

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 restraint's upper anchorages (D-rings) were adjustable.

Upon inspection, the driver's restraint webbing was stowed in the retractor and operational. The left front D-ring was adjusted to the full up position. Examination of the webbing and latch plate hardware revealed no evidence of use during the crash. Inspection of the surface of the D-ring similarly was unremarkable. The driver's buckle pre-tensioner had not fired, **Figure 6**. The post-crash measurement of the pre-tensioner's barrel was 110 mm (4.3 in). Inspection of the driver's belt system indicated the driver was unrestrained at the time of the crash.

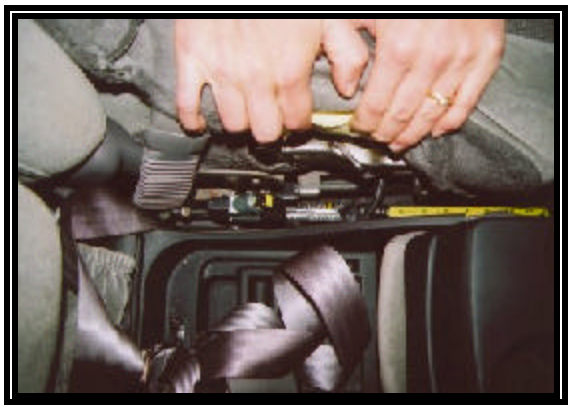


Figure 6: View of the left buckle pretensioner.

There was no intrusion or interior damage related to the exterior forces of the crash. The driver knee bolster was not deformed, however two areas of contact were identified. The surface of the panel was scuffed from minor contact by the driver's lower extremities. The right scuff measured 1 cm x 5 cm (0.5 in x 2 in), width by height. It was located 14.0 cm (5.5 in) left of the steering column centerline and 46 cm (18 in) above the floor. The left contact measured 2 cm (1 in) in diameter. It was located 1.0 cm (0.5 in) right of the steering

column centerline and 44.5 cm (17.5 in) above the floor. A 8.9 cm (3.5 in) scuff was identified on the brow of the instrument panel directly forward of the steering wheel's 12 o'clock sector from probable contact with the driver's right hand. The fabric of the left sun visor was cut and also scuffed from probable contact with the driver's head. The contact with the sun visor was located 18 cm (7 in) left of the vehicle's center line. None of these interior contacts resulted in injury to the driver of the Taurus.

The foot controls were not adjustable. The left aspect of the brake pedal pad was deformed (rotated forward). The pedal deformation resulted from the off-center application of the brake (relative to the brake actuation arm) by the unrestrained driver at the time of the crash.

The angle of the steering wheel rim was adjustable. It had a 4-notch adjustment and was positioned one notch below 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 coupling on the lower aspect of the column was intact.

The frontal air bag system consisted of redesigned dual stage air bags for the driver and front right passenger. The air bags did not deploy in the below threshold crash. The driver module was located in the typical manner in the center hub of the steering wheel rim. The front right passenger module was a top mount configuration located in the right aspect of the instrument panel. The SRS indicator lamp in the driver's instrument cluster was queried during the inspection for possible fault codes. Upon ignition, the SRS indicator lamp illuminated steady for 6 seconds during the diagnostic sequence. The lamp then went off and stayed off. The condition of the lamp indicated there were no faults within the Supplemental Restraint System post-crash.

DRIVER DEMOGRAPHICS

Age/Sex:	46 year old/ Male
Height:	180 cm (71 in)
Weight:	98 kg (215 lb)
Restraint Use:	Unrestrained
Usage Source:	SCI inspection, Occupant Kinematics, RCM
Medical treatment:	No Injury

ATTACHMENT A

2000 Taurus/Sable EDR Report - Summary Page

Investigation Data

File Name:	CA(0-038.hex	File SaveDate:	11-Oc:-2000
File Read-out Date:	N/A	Report Date:	20-Oc:-2000
Report Version:	1.4		

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:	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

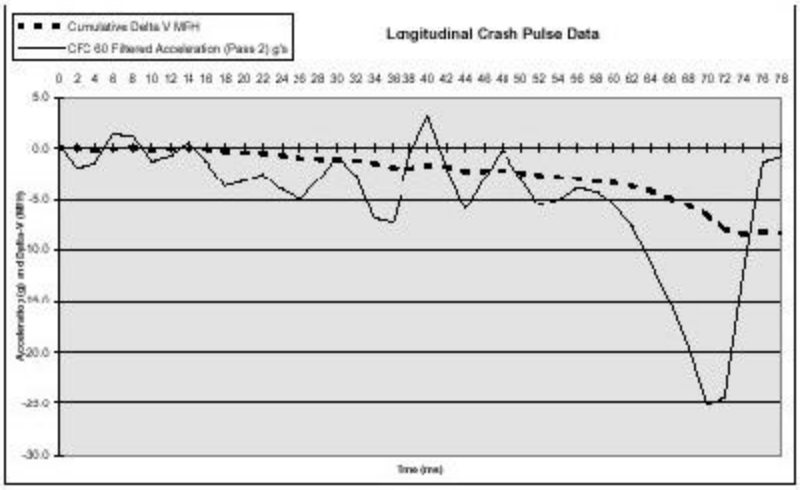
Driver Seat Belt Buckle:	Not Engaged
Passenger Seat Belt Buckle:	Not Engaged
Driver Seat Track In Forward Position:	No
Passenger Seat Weight Switch Position:	N/A

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

2000 Taurus/Sable EDR Report - Charts

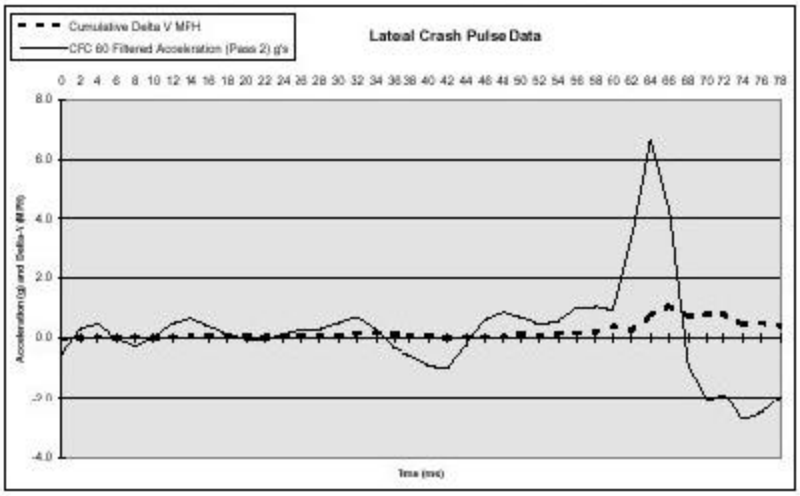
Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.1	-0.1	-0.6	-1.1	-1.6	-2.1	-3.4	-6.7	-9.5



Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.0	0.0	0.1	0.1	0.1	0.3	0.4	0.7	0.4



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