TRANSPORTATION SCIENCES
CRASH RESEARCH SECTION

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ADVANCED OCCUPANT PROTECTION SYSTEM STUDY
2000 FORD TAURUS INVESTIGATION

VERIDIAN CASE NO. CA00-013

LOCATION - MICHIGAN

CRASH DATE - MARCH 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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This on-site investigation focused on the performance of the redesigned occupant protection system in the 2000 Ford Taurus. The occupant protection system, 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. A Restraint Control Module (RCM) monitored and controlled the deployment of the various safety systems and had the capability to record crash event data. The subject 2000 Ford Taurus was the striking vehicle in a front-to-rear chain reaction crash that involved a 1987 Chevrolet ½ ton pick-up and a 1988 Ford Taurus. The 31 year old male driver of the Ford was restrained at the time of the crash by the vehicle's 3-point lap and shoulder belt. He was not injured.

The crash was identified through the weekly poll of the police agencies conducted by the General Estimates System (GES). This crash report was forwarded to the Special Crash Investigations team at Veridian Engineering on May 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 and downloading the RCM. The vehicle had been partially repaired at the time of the SCI investigation.

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ADVANCED OCCUPANT PROTECTION SYSTEM STUDY
2000 FORD TAURUS
VERIDIAN CASE NO: CA00-013
LOCATION: MICHIGAN
CRASH DATE: MARCH, 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, 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. A Restraint Control Module (RCM) monitored and controlled the deployment of the various safety systems and had the capability to record crash event data. The subject 2000 Ford Taurus was the striking vehicle in a front-to-rear chain reaction crash that involved a 1987 Chevrolet ½ ton pick-up and a 1988 Ford Taurus. The 31 year old male driver of the Ford was restrained at the time of the crash by the vehicle's 3-point lap and shoulder belt. He was not injured.

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SUMMARY

Crash Site

This three-vehicle crash occurred during the early evening hours of March, 2000. It was dusk at the time of the crash and the weather was not a factor. The road surface was dry. At the scene, the primary roadway was configured with two lanes, east/west in direction. 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 on the intersecting roadway. The speed limit in the area of the crash was 64 km/h (40 mph). **Figure 1** is a diagram of the crash scene.

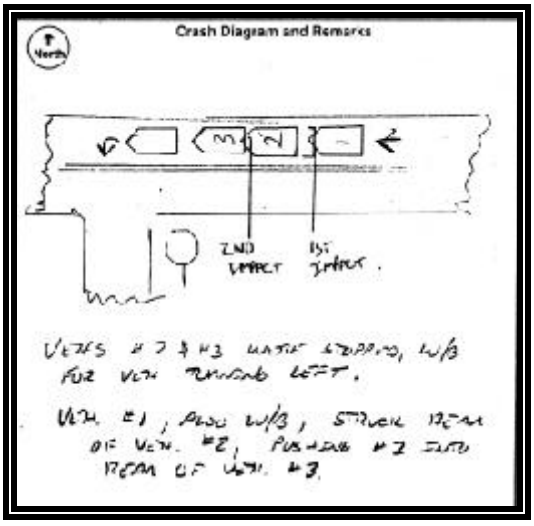


Figure 1: Crash scene diagram.

Pre-Crash

The 2000 Ford Taurus was westbound driven by a 31 year old male. He had a reported height and weight of 185 cm (73 in) and 83 kg (182 lb) and was restrained by the vehicle's manual 3-point lap and shoulder belt system. The Ford was the third vehicle in a string of traffic. A 1987 Chevrolet ½ ton pick-up and a 1988 Ford Taurus were ahead of the subject vehicle. The driver reported traffic was moving at speeds in the range of 48 to 64 km/h (30 to 40 mph). As the traffic approached the 3-leg intersection, the traffic in front of the Taurus began braking. A non-contact vehicle was stopped in the westbound lane at the 3-leg intersection. It was the driver's intension to turn left onto the intersecting road. The vehicle was stopped for an unknown duration waiting for eastbound traffic to clear. The 1988 Ford Taurus and a 1987 Chevrolet ½ ton pick-up came to a stop behind this vehicle.

Crash

The crash occurred when the driver of the 2000 Ford Taurus began to brake too late to completely stop. The front plane of the Ford struck and under-rode the rear of the Chevrolet in 12/6 o'clock impact configuration. The force of the impact was above the pre-tensioner threshold and caused the left pre-tensioner to fire. The crash force was below the required threshold to warrant frontal air bag deployment. The frontal air bags did not deploy. The delta V of the impact was an estimated 16 km/h (10 mph).

The impact displaced the Chevrolet pick-up forward and into secondary contact with the 1988 Ford Taurus. The front plane of the Chevrolet impacted the back plane of the 1988 Ford resulting in minor non-disabling damage. The vehicles came to rest on the roadway and in-line with each other. All three vehicles were operational and drove away from the crash scene. None of the involved occupants were injured.

2000 FORD TAURUS

The 2000 Ford Taurus was identified by the Vehicle Identification number (VIN): 1FAFP5521YG (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 date of manufacture was January, 2000. The odometer read 10,219 km (6350 miles) at inspection.

Exterior Damage

The vehicle had been partially repaired by the time of inspection due to the delayed crash notification. **Figure 2** is a view of the frontal damage taken during the insurance appraisal of the vehicle. The impact damage to the Taurus was confined to vehicle's structures forward of the radiator support plane. The direct contact damage began 20 cm (8 in) left of center and extended laterally 91 cm (36 in) to the right front bumper corner. The hood was slightly buckled and exhibited 6.3 cm (2.5 in) longitudinal scratches along its leading edge in the region of direct contact. The front fenders were not damaged in the impact. The Collision Deformation Classification (CDC) was 12-FZEW-01. The estimated delta V of the impact based on forensic analysis of the damage and SCI experience was 16 km/h (10 mph). The RCM measured, calculated and recorded a 10.6 km/h (6.6 mph) delta V which occurred at 78 msec. It should

be noted the RCM its not capable of recording the entire crash pulse and the stored delta V may not be the maximum delta V of the crash. The data sheets from the Restraint Control Module download are included at the end of this report as **Attachment A**.

The components replaced included the following: impact bar, absorber, bumper fascia, grille, head lamp assemblies, upper and lower radiator supports, complete core, air conditioner condenser, fan, hood, battery, fuse box and the front air bag sensor. The repair record indicated the left frame rail was straightened as well. **Figure 3** is a right front view of the vehicle taken at the time of its inspection.

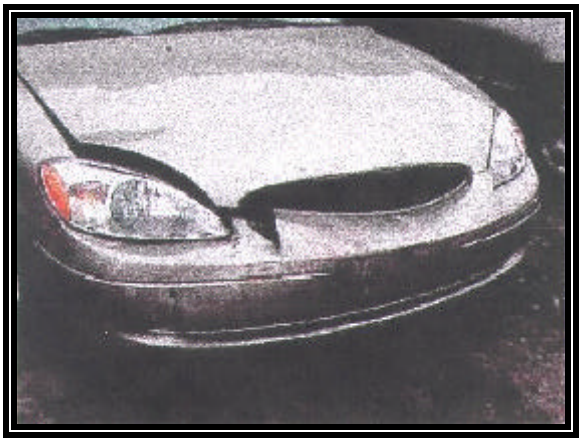


Figure 2: Insurance photo taken of the frontal damage during appraisal.

Figure 3: Right front view of the repaired Ford Taurus.

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 center console 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. These data were downloaded by the SCI investigator during the vehicle inspection.

Figure 4 is a left interior view of the front occupant compartment. The driver's seat was adjusted in a mid-to-rear track position at inspection and measured 9.6 cm (3.8 in) forward of full rear. It could not be verified if this was the at-crash position. Adjustment of the track position was controlled electronically by a switch located on the forward outboard aspect of the cushion. The driver did report he typically positioned his seat mid-to rear track and this position was consistent with his stature. The foot controls were not adjustable.

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 fired as a result of the crash, **Figure 5**. The post-crash measurement of the pretensioner's piston was 60.3 mm (2.38 in). The restraint's upper anchorages (D-rings) were adjustable. The left front D-ring was adjusted to the full up position. Upon inspection, the driver's restraint webbing was stowed in the retractor and operational. No witness marks indicative of use during the crash were identified on the webbing or hardware surfaces. However, given the relatively minor magnitude of the crash belt evidence would not be expected.

Figure 4: Left interior view.

Figure 5: View of the left buckle.

The Supplemental Restraint System (SRS) consisted of dual stage driver and front right passenger air bags. 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. There was no deformation of the steering wheel rim nor shear capsule displacement. 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) and then repeatedly flashed a code 19. The 19 flash code presumably indicated a pretensioner in the restraint system had fired. The RCM download revealed their were no fault codes present prior to the crash.

DRIVER DATA

The driver of the Ford Taurus was a 31 year old with a reported height and weight of 185 cm (73 in) and 82 kg (183 lb). He was seated in a mid-to-rear seat track position and was restrained by the vehicle's 3-point lap and shoulder belt system. In his interview, he indicated he had rented and was driving the vehicle

in the course of his employment. He was traveling in steady traffic at approximately 48 to 64 km/h (30 to 40 mph). Traffic in front of him began braking aggressively due to stopped traffic. He also braked hard but was unable to completely stop prior to the crash.

Upon impact, the Restraint Control Module recognized the force of the crash and fired the buckle pretensioner in the left restraint. The vehicle sensitive (inertial) retractor locked and the belt webbing tightened about the driver. The driver responded to the 12 o'clock direction of the crash by loading the restraint system. No interior occupant contacts were identified and the driver was not injured. The manual restraint system was very effective in protecting the driver in this minor severity crash.

ATTACHMENT A

2000 Taurus/Sable EDR Report - Summary Page

Investigation Data

File Name:	ca00-013.hex	**File Save Date:**	11-May-2000
File Read-out Date:	N/A	**Report Date:**	26-May-2000
Report Version:	1.0		

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:	31
Time From Algorithm Wakeup to First Stage - Unbelted:	33
Time From Algorithm Wakeup to First Stage - Belted:	0
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:	31	Unbelted
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

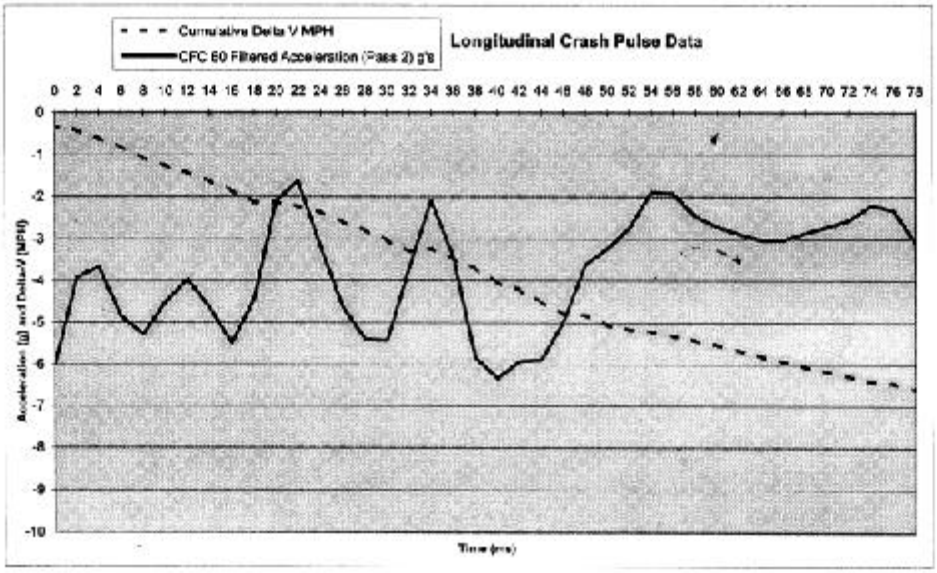
Notes

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. CFC 60 is a Butterworth 4-pole phaseless digital filter. (See SAE J211 Part 1 Appendix C dated March 1995.)
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)	0.3	-1.3	-2.3	-3.9	-4.9	-5.9	-5.5	-6.2	-6.6



Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.0	0.1	0.2	0.2	0.0	-0.4