

**CRASH DATA RESEARCH CENTER**

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**ADVANCED OCCUPANT PROTECTION SYSTEM STUDY (AOPSS)**

**VERIDIAN CASE NO. CA00-035**

**VEHICLE - 2000 FORD TAURUS LX**

**LOCATION - STATE OF NEW JERSEY**

**CRASH DATE - AUGUST, 2000**

Contract No. DTNH22-94-D-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 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.

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**VERIDIAN CASE NO. CA00-035**  
**VEHICLE - 2000 FORD TAURUS LX**  
**LOCATION - STATE OF NEW JERSEY**  
**CRASH DATE - AUGUST, 2000**

***BACKGROUND***

This on-site investigation focused on the Advanced Occupant Protection System (AOPS) of a 2000 Ford Taurus LX 4-door sedan. The Ford Taurus was equipped with dual stage frontal air bags for the driver and front right passenger positions which deployed as a result of a rear-end collision with a 1997 Chevrolet C-1500 pickup truck. The driver of the Ford Taurus was operating the vehicle westbound on approach to a rural 4-leg intersection when he failed to observe traffic slowing ahead. As the Ford approached the intersection, the frontal area struck the rear area of the Chevrolet pickup resulting in moderate damage to both vehicles. The restrained 35 year old male driver of the 2000 Ford Taurus initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint and deployed driver air bag. Loading of the manual restraint resulted in a contusion to the left upper chest. He also sustained a small thermal burn to the anterior aspect of the left wrist from venting air bag gases. The Ford driver did not seek medical treatment.

The crash was identified by NASS PSU 04 during normal sampling activities on August 29, 2000. Although not selected as a CDS case, the police crash report was forwarded to the Veridian SCI team with subsequent notification provided to NHTSA. Due to the new Advanced Occupant Protection System and deployment of the redesigned frontal air bag system, the crash was assigned as an on-site investigative effort on August 30. The on-site investigator completed the investigation on Thursday, August 31, 2000.

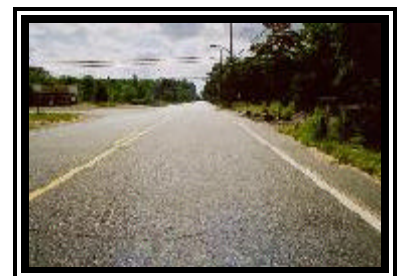
***SUMMARY***

**Crash Site**

This three vehicle crash occurred during the afternoon hours of August, 2000. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the westbound lane of a straight/level 4-leg rural intersection (see **Figure 8 - page 6**). The east/westbound lanes consisted of two asphalt travel lanes which were bordered by narrow paved shoulders. Traffic control through the intersection was controlled by stop signs for north/southbound traffic. The posted speed limit at the crash site was 80 km/h (50 mph).

**Pre-Crash**

The 51 year old male driver of a 1993 Toyota Tacoma pickup truck was operating the vehicle westbound when he slowed in anticipation of a left turn (south) at the 4-leg intersection (**Figure 1**). The 33 year old male driver of the 1997 Chevrolet C-1500 extended cab pickup truck was also operating the vehicle westbound (behind the Toyota) when he reportedly observed the Toyota slow abruptly in preparation of the left turn. The Chevrolet driver braked in avoidance of the impending crash. The 35 year old



**Figure 1. Westbound approach to the crash site.**

male driver of the 2000 Ford Taurus was operating the vehicle westbound (behind the Chevrolet) when he failed to observe the Chevrolet brake suddenly in avoidance of the lead vehicle. Upon recognition of the impending harmful event, the Ford driver braked in avoidance remaining in the westbound lane prior to the collision.

### **Crash**

As the Toyota slowed in preparation of the left turn (south) at the 4-leg intersection, the frontal area of the Chevrolet pickup truck struck the rear area of the Toyota pickup truck resulting in (police reported) minor damage to both vehicles. At this point, the frontal area of the Ford Taurus impacted the rear area of the Chevrolet pickup truck resulting in moderate damage to both vehicles. The pre-crash braking actions of both drivers produced an underride/override configuration as the Ford underrode the Chevrolet which allowed the bumper on the Ford to engage the structure under the Chevrolet pickup. The missing vehicle algorithm of the WinSMASH program computed velocity changes of 18.7 km/h (11.6 mph) for the subject vehicle and 14.2 km/h (8.8 mph) for the struck Chevrolet pickup. Respective longitudinal components were -18.7 km/h (-11.6 mph) and 14.2 km/h (8.8 mph). The impact induced deceleration was sufficient to deploy the Ford's Advanced Occupant Protection System. The Ford's Event Data Recorder (EDR) recorded a longitudinal element of -18.6 km/h (-11.6 mph) as a *first stage deployment* (see **Figures 9 & 10, page 7**). All vehicles came to rest in close proximity to their respective point of impact facing west.

### **Post-Crash**

The Ford driver exited the vehicle under his own power. The exit status of the other vehicle occupants were unknown. No ambulance was summoned to the crash site. The Ford Taurus was towed from the scene due to disabling damage as the Toyota Tacoma and Chevrolet C-1500 pickup trucks were driven from the scene with non-disabling damage.

### **VEHICLE DATA**

The 2000 Ford Taurus LX was manufactured on 2/00 and identified by the vehicle identification number (VIN): 1FAFP5226YG (production number deleted). The county-owned vehicle was a 4-door sedan equipped with front-wheel drive, ABS and a 3.0 liter, V-6 engine. At the time of the crash, the odometer had recorded 16,899 km (10,501 miles). The seating was configured with front bucket and rear bench seats. Adjustable pedals were not present. The driver reported no previous crashes or maintenance on the Ford's air bag system. A cellular flip phone was present but not in use at the time of the collision.

### **VEHICLE DAMAGE**

#### **Exterior**

The Ford Taurus sustained moderate frontal damage as a result of the impact with the Chevrolet pickup truck (**Figure 2**). The direct contact damage began 2.0 cm (0.8 in) to the left of the front right bumper corner and extended 108.0 cm (42.5 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 142.0 cm (55.9 in). Six crush measurements were documented at the level of the bumper:



**Figure 2. Frontal damage to the 2000 Ford Taurus LX.**

C1= 0 cm, C2= 0 cm, C3= 5.0 cm (2.0 in), C4= 7.0 cm (2.8 in), C5= 15.0 cm (5.9 in), C6= 2.0 cm (0.8 in). A secondary profile was obtained 14.0 cm (5.5 in) above the level of the bumper to capture the underride damage resulting in an *averaged profile* of: C1= 0 cm, C2= 0 cm, C3= 12.0 cm (4.7 in), C4= 14.0 cm (5.5 in), C5= 15.0 cm (5.9 in), C6= 2.0 cm (0.8 in). The Collision Deformation Classification (CDC) for this impact to the Ford was 12-FDEW-1 with a principal direction of force of 0 degrees. The grille separated intact while the right headlight fractured during the collision sequence. The hood was deformed up and rearward from the underride. Reduction in the left side wheelbase measured 2.0 cm (0.8 in). The windshield sustained no damage from exterior impact forces.

### **Interior**

Interior damage to the Ford identified through the vehicle inspection was minimal and was attributed to occupant contact. Small scuff marks were documented on the left knee bolster (rigid plastic type) and mid-instrument panel area. A scuff mark was also noted to the right upper windshield area attributed to the passenger air bag deployment.

### **MANUAL RESTRAINT SYSTEMS**

The interior of the Ford Taurus consisted of a six passenger seating configuration with front bucket and rear bench seats. The front left 3-point manual restraint consisted of a continuous loop belt webbing with a sliding latchplate and dual mode retractors (inertial lock/belt sensitive). Loading marks were identified on the shoulder portion of the webbing which supports usage (**Figure 3**). The front right 3-point manual lap and shoulder belt system consisted of a continuous loop belt webbing with a sliding latchplate and a retractor equipped with an inertial and switchable lock mechanism. The center front seat (“flip and fold” console) was equipped with a 2-point manual lap belt. The rear seating positions were equipped with 3-point manual lap and shoulder belt systems which consisted of continuous loop belt webbings with sliding latchplates that retracted into inertial sensitive and switchable locking retractors.



**Figure 3. Loading marks to the front left shoulder belt webbing.**

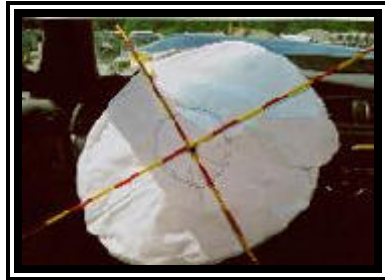
### **ADVANCED OCCUPANT PROTECTION SYSTEM**

The Ford Taurus was equipped with dual stage frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the crash (**Figure 4**). The driver air bag was identified by the following part number: TXM000331713 with a bar coded lot number of: P5206000-00D. The air bag was housed in the center of the steering wheel with a horizontally oriented flap tear seam (H-configuration). The flaps were nearly symmetrical in shape as the upper flap measured 17.5 cm (6.9 in) in width and 6.5 cm (2.6 in) in height while the lower flap measured 17.5 cm (6.9 in) in width and 5.0 cm (2.0 in) in height. No contact evidence was identified on the air bag or exterior surface of the module cover flaps. The diameter of the driver air bag measured 58.5 cm (23.0 in) in its deflated state (**Figure 5**). The bag was tethered by two internal straps and vented by two ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag.



**Figure 4. 2000 Ford Taurus LX deployed frontal air bags.**

The front right passenger air bag deployed from the right top instrument panel area with a single cover flap design hinged at the forward aspect. The cover flap was somewhat rectangular in shape and measured 28.0 cm (11.0 in) in width and 9.0 cm (3.5 in) in height along the left edge of the flap and 13.0 cm (5.1 in) in height along the right edge. Multiple black vinyl transfers were noted to the right upper quadrant of the air bag face from expansion within the module. In addition, passenger air bag contact to the right windshield produced the noted scuff mark to the mid-windshield area. The passenger air bag measured 52.0 cm (20.5 in) in width and 53.0 cm (20.9 in) in height in its deflated state (**Figure 6**). The bag was vented by two ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the air bag. No internal tether straps were present.



**Figure 5. 2000 Ford Taurus LX deployed redesigned driver air bag.**



**Figure 6. 2000 Ford Taurus LX deployed redesigned passenger air bag.**

The Ford was also equipped with side impact air bags for the front seated positions. The air bag modules were housed in the outboard side aspect of the front seat backs, and did not deploy as a result of the crash.



**Figure 7. Front left restraint activated belt pretensioner.**

The driver's restraint system also included a buckle pretensioner mounted longitudinally alongside the seat cushion (**Figure 7**). The deployment of this pretensioner resulted in 7.0 cm (2.8 in) of piston movement. The piston pulls a cable which lowers the height of the buckle assembly, reducing slack in both the lap and shoulder belt webbing.

### ***DRIVER DEMOGRAPHICS***

Age/Sex:	35 year old male
Height:	183 cm (72 in)
Weight:	93 kg (205 lb)
Seat Track Position:	Full rearward position
Manual Restraint Use:	3-point lap and shoulder belt system
Usage Source:	Vehicle inspection, driver interview, police report
Eyewear:	Sunglasses
Type of Medical Treatment:	None



## **Driver Injuries**

<b><i>Injury</i></b>	<b><i>Severity (AIS 90)</i></b>	<b><i>Injury Mechanism</i></b>
Left upper chest contusion	Minor (490402.1,2)	Shoulder belt webbing
Left anterior wrist thermal burn	Minor (792000.1,2)	Venting driver air bag gases

*Source: driver*

## **Driver Kinematics**

The 35 year old male driver of the 2000 Ford Taurus was restrained by the available 3-point manual lap and shoulder belt system, seated in an upright posture with the seat track adjusted to the full rearward position. His hands were placed at the 10 o'clock and 2 o'clock positions on the steering wheel rim. Belt usage was confirmed by the loading marks documented to the shoulder webbing of the front left manual restraint in conjunction with the deployment of the pretensioner system.

At impact, the driver initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint system and deployed driver air bag. Loading of the manual restraint resulted in a contusion to the left upper chest area. He also sustained a thermal burn to the anterior aspect of the left wrist from the (driver) venting air bag gases. This injury mechanism was evidenced by the size and location of the injury relative to the driver's stated pre-crash placement of the hands on the steering wheel rim. The driver did not seek medical treatment for his injuries. The Advanced Occupant Protection System provided additional protection against further contact to the steering wheel hub/rim, and potential serious injury.

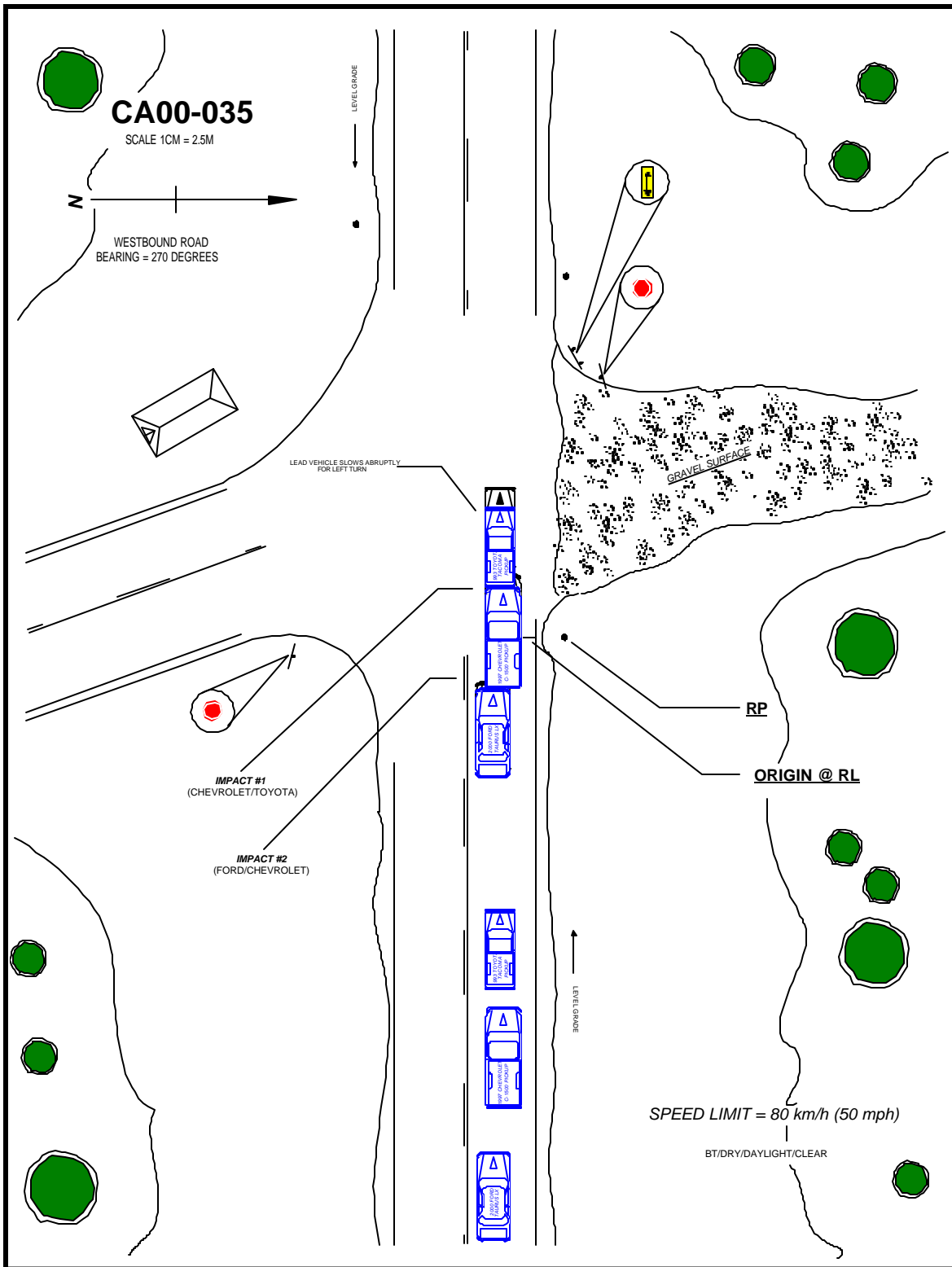


Figure 8. Scene Diagram.

## 2000 Taurus/Sable EDR Report - Summary Page



### Investigation Data

File Name:	C:\00-035.hox	File Save Date:	05-Sep-2000
File Read-out Date:	WA	Report Date:	06-Sep-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:			C

### Algorithm Times

Actual initiation depends on restraint system status (below).

	ms
Time From Algorithm Wakeup to Pretensioner:	10
Time From Algorithm Wakeup to First Stage - Unbelted:	26
Time From Algorithm Wakeup to First Stage - Belted:	26
Time From Algorithm Wakeup to Second Stage:	U

### 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:	18	Unstaged
Time From Algorithm Wakeup to First Stage Deployment Attempt:	29	26
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Discosa	Discosa

### Notes

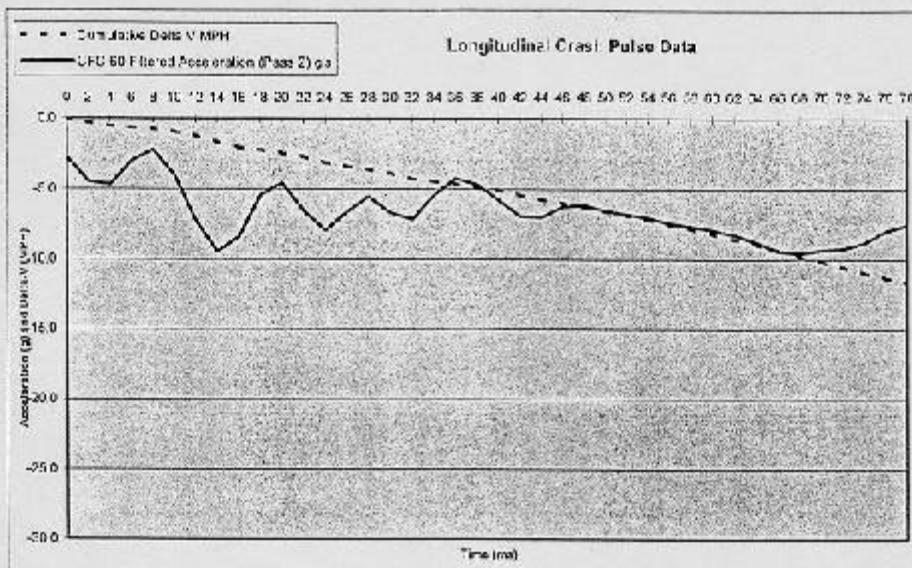
1. Read-out date is set by the PC interface tool.
2. Features and data parameters which are not available on the module are marked "N/A".
3. CFC GC is a Catterworth 4-pole phaseless digital filter. (See SAE J211 Part I Appendix C dated March 1995.)
4. Total and maximum Delta-Y results are not available 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.

Figure 9. 2000 Ford Taurus LX EDR Report.

## 2000 Taurus/Sable EDR Report - Charts

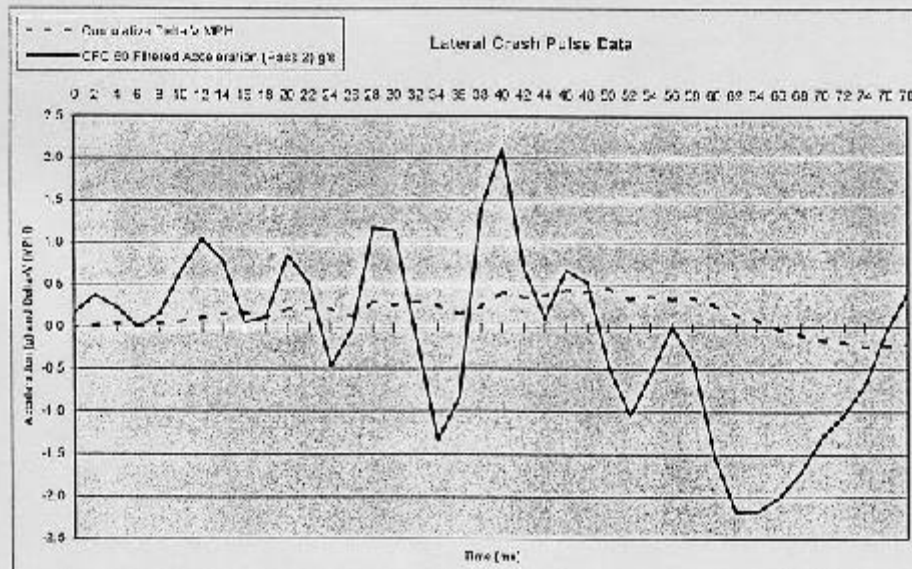
### Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	-9.2	-9.9	-1.5	-1.8	-5.1	-6.6	-11.2	-16.1	-11.6



### Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.0	0.3	1.2	1.3	0.4	1.5	0.3	-0.2	-0.2



File Name: Ca00-035.inx

Figure 10. 2000 Ford Taurus LX EDR Report.