

**CRASH DATA RESEARCH CENTER**

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

**VERIDIAN CASE NO. CA00-042**

**VEHICLE - 2000 FORD TAURUS LX**

**LOCATION - STATE OF PENNSYLVANIA**

**CRASH DATE - AUGUST, 2000**

Contract No. DTNH22-94-D-07058

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Washington, D.C. 20590

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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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<p>16. <i>Abstract</i> This investigation focused on the performance of the Advanced Occupant Protection System (AOPS) of a 2000 Ford Taurus LX 4-door sedan. The Ford Taurus was equipped with frontal air bags for the driver and front right passenger positions which deployed as a result of a right angle collision with a 1999 Ford F-150 extended cab pickup truck. The driver of the Ford Taurus was operating the vehicle northbound when she failed to observe the stop sign or westbound Ford pickup truck as she proceeded straight through a 4-leg intersection. As both vehicles entered the intersection, the front right area of the Ford Taurus impacted the left front side surface of the Ford pickup truck resulting in moderate damage to each vehicle. A secondary (sideslap) impact resulted in deployment of the Ford Taurus' right front side impact air bag. The restrained 70 year old female driver of the Ford Taurus initiated a forward and slightly lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed driver air bag. She sustained a small laceration to the posterior aspect of the left forearm from contact to an unknown component. She was transported to a local hospital for treatment and released.</p>			
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**ADVANCED OCCUPANT PROTECTION SYSTEM STUDY (AOPSS)  
VERIDIAN CASE NO. CA00-042  
VEHICLE - 2000 FORD TAURUS LX  
LOCATION - STATE OF PENNSYLVANIA  
CRASH DATE - AUGUST, 2000**

***BACKGROUND***

This investigation focused on the performance of the Advanced Occupant Protection System (AOPS) of a 2000 Ford Taurus LX 4-door sedan. The Ford Taurus was equipped with frontal air bags for the driver and front right passenger positions which deployed as a result of a right angle collision with a 1999 Ford F-150 extended cab pickup truck. The driver of the Ford Taurus was operating the vehicle northbound when she failed to observe the stop sign or westbound Ford pickup truck as she proceeded straight through a 4-leg intersection. As both vehicles entered the intersection, the front right area of the Ford Taurus impacted the left front side surface of the Ford pickup truck resulting in moderate damage to each vehicle. A secondary (sideslap) impact resulted in deployment of the Ford Taurus' right front side impact air bag. The restrained 70 year old female driver of the Ford Taurus initiated a forward and slightly lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed driver air bag. She sustained a small laceration to the posterior aspect of the left forearm from contact to an unknown component. She was transported to a local hospital for treatment and released.

The crash notification was provided to NHTSA on Thursday, October 5, 2000. Although the crash occurred in the state of Pennsylvania, the vehicle was purchased by a Buffalo, New York salvage yard and transported to the Buffalo location. Due to the Advanced Occupant Protection System and deployment of the frontal air bag system, the crash was assigned as a limited on-site investigative effort October 6. The vehicle inspection was completed Tuesday, October 10, 2000.

***SUMMARY***

**Crash Site**

This two vehicle crash occurred during the morning 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 at a straight and level 4-leg rural intersection (see **Figure 11 - page 7**) which had a posted speed limit of 40 km/h (25 mph). Traffic control consisted of stop signs for north/southbound traffic. The asphalt roadway was bordered by barrier curbs and residential driveways.

**Pre-Crash**

The 70 year old female driver of the 2000 Ford Taurus LX was operating the vehicle northbound at a (driver reported) speed of 56 km/h (35 mph) when she failed to observe the stop sign or westbound Ford pickup truck as she proceeded straight through a rural 4-leg intersection (**Figure 1**). She reported no avoidance maneuvers in anticipation of the impending crash.



**Figure 1. Police photograph showing northwest view of intersection.**

The 41 year old male driver of the 1999 Ford F-150 pickup truck was operating the vehicle westbound at a (police reported) speed of 40 km/h (25 mph) when he entered the intersection across the path of the Ford Taurus. The police reported no tire marks at the scene indicative of driver avoidance maneuvers. The front right position was occupied by a restrained 13 year old male.

### Crash

As both vehicles entered the 4-leg intersection, the front right area of the Ford Taurus impacted the left front side surface of the Ford pickup truck resulting in moderate damage to each vehicle. The missing vehicle algorithm of the WinSMASH reconstruction program computed velocity changes of 19.2 km/h (11.9 mph) for the subject vehicle and 14.8 km/h (9.2 mph) for the Ford pickup. The respective longitudinal components were -16.6 km/h (-10.3 mph) and -7.4 km/h (-4.6 mph). The Ford Taurus' event data recorder (EDR) recorded a longitudinal Delta-V of -18.5 km/h (-11.5 mph) at the 78 millisecond time frame (see **Figures 12 & 13 - page 7**). The speed change exceeded the threshold required for deployment, therefore, the Ford Taurus' frontal air bag system (*and the left front buckle pretensioner*) deployed.

At this point, both vehicles began their respective post-impact trajectories towards the northwest sector of the intersection as the right rear side surface of the Ford Taurus struck ("sideslapped") the left rear side surface of the Ford pickup truck which resulted in moderate damage to each vehicle. The missing vehicle algorithm of the WinSMASH reconstruction program computed velocity changes of 13.8 km/h (8.6 mph) for the subject vehicle and 10.6 km/h (6.6 mph) for the Ford pickup. The respective latitudinal components were of -13.8 km/h (-8.6 mph) and 10.6 km/h (6.6 mph). This secondary impact resulted in deployment of the Ford Taurus' right front side impact air bag. Both vehicles sustained contact to final rest in the northwest sector of the intersection facing west (**Figures 2 & 3**).



Figure 2. Police photo west showing vehicle final rest positions.



Figure 3. Police photo east showing vehicle final rest positions.

### Post-Crash

The driver of the 2001 Ford Taurus LX exited the vehicle through the left door with some assistance from rescue personnel. The exit status of the Ford pickup truck occupants were unknown. Treatment was rendered at the scene by fire department personnel and emergency medical technicians (EMTs). The driver of the Ford Taurus was subsequently transported by ambulance to a local hospital for treatment and released. The driver and front right passenger of the Ford pickup truck reported to police complaints of pain to the neck and head (respectively) but were not transported from the scene for treatment. Both vehicles were towed from the crash site due to disabling damage.

## VEHICLE DATA

The 2000 Ford Taurus LX was manufactured in April, 2000 and identified by the vehicle identification number (VIN): 1FAFP5223YA (production number deleted). The driver-owned vehicle was a 4-door sedan equipped with front-wheel drive and a 3.0 liter, V-6 engine. At the time of the crash, the odometer had recorded 2,816 km (1,750 miles). The seating was configured with front bucket and rear bench seats. Adjustable pedals were not present in the vehicle. The driver reported no previous crashes or maintenance on the Ford's frontal air bag system. No cell phone was present in the vehicle.

## VEHICLE DAMAGE

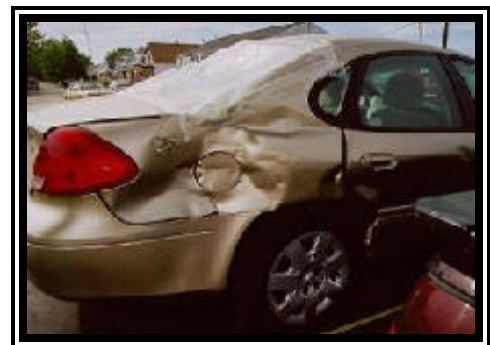
### Exterior

The 2000 Ford Taurus LX sustained moderate frontal damage as a result of the impact with the 1999 Ford F-150 pickup truck (**Figure 4**). The direct contact damage began at the front right bumper corner and extended 93.0 cm (36.6 in) inboard. The impact deformed the full frontal width resulting in a combined direct and induced damage length (Field L) of 131.0 cm (51.6 in). Six crush measurements were documented at the level of the reinforcement bar (*bumper fascia separation*): C1= 1.0 cm (0.4 in), C2= 9.0 cm (3.5 in), C3= 13.0 cm (5.1 in), C4= 19.0 cm (7.5 in), C5= 21.0 cm (8.3 in), C6= 11.0 cm (4.3 in). The Collision Deformation Classification (CDC) for this initial impact to the Ford was 81-FZEW-1 with a principal direction of force of (+) 30 degrees (principal direction of force incremented to reflect end structure shift to the left). The hood was deformed up and rearward from engagement against the side surface of the Ford pickup truck. An indentation was noted to the front reinforcement bar attributed to the left front bumper corner of the Ford pickup truck. The grille and left headlight assembly fractured and separated from the vehicle during the crash sequence. The fenders were displaced to the left due to 12.0 cm (4.7 in) of end structure shift. This damage pattern restricted the left front wheel/tire (not deflated) and produced additional induced damage along the left front door area. The windshield was fractured along the lower right A-pillar from exterior impact forces only. Reduction in the left side wheelbase measured 12.0 cm (4.7 in) as the right wheelbase was elongated 3.5 cm (1.4 in). Direct contact damage was also documented along the right fender area attributed to sustained contact during vehicle spinout (*and accurately separated from impact #2 damage*).



**Figure 4.** Front right damage to the 2000 Ford Taurus LX.

Direct contact damage was also documented along the right side surface attributed to the secondary (sideslap) impact (**Figure 5**). The direct contact damage began 54.0 cm (21.3 in) forward of the right rear bumper corner and extended 310.0 cm (122.0 in) forward. The combined direct and induced damage length (Field L) began 20.0 cm (7.9 in) forward of the right rear bumper corner and extended 244.0 cm (96.1 in) forward. Six crush measurements were documented at the level of the mid-door: C1= 0 cm, C2= 13.0 cm (5.1 in), C3= 6.0 cm (2.4 in), C4= 4.0 cm (1.6 in), C5= 2.0 cm (0.8 in), C6= 0 cm. The CDC for this secondary impact to the Ford Taurus was 03-RZAW-2 with a principal direction of force of (+) 90



**Figure 5.** Secondary impact damage to the right rear side surface.

degrees. Pocketing was noted aft of the right rear axle with surface scratching extended forward to the right A-pillar. A rubber transfer was documented to the right rear door attributed to the left rear wheel/tire on the Ford pickup truck. Induced damage disintegrated the (tempered) back light glazing.

### **Interior**

Interior damage to the Ford Taurus identified through the vehicle inspection was minimal and was attributed to occupant contact. The accelerator pedal was displaced slightly to the right. Small smudge marks were noted on the left front roof and side rail area. No component intrusions, rim deformation, column compression or left knee bolster contacts were found.

### **MANUAL RESTRAINT SYSTEMS**

The interior of the Ford Taurus consisted of a five passenger seating configuration with front bucket and rear bench seats. The driver 3-point manual lap and shoulder belt system consisted of a continuous loop belt webbing with a sliding latchplate and a dual mode retractor (load limiter inertial lock/belt sensitive with torsion bar). No loading evidence was identified on the driver restraint. 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 rear seating positions were equipped with 3-point manual lap and shoulder belt systems which consisted of a continuous loop belt webbing with a sliding latchplate that retracted into an inertial sensitive and switchable locking retractor.

### **ADVANCED OCCUPANT PROTECTION SYSTEM**

The Ford Taurus was equipped with redesigned frontal air bags for the driver and front right passenger positions. The air bags had deployed as a result of the crash (**Figure 6**). The driver air bag was identified by the following part number: TXM000860908 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 16.5 cm (6.5 in) in width and 6.5 cm (2.6 in) in height while the lower flap measured 16.5 cm (6.5 in) in width and 4.6 cm (1.8 in) in height. No contact evidence was identified on the exterior surface of the module cover flaps. The diameter of the driver air bag measured 53.0 cm (20.9 in) in its deflated state (**Figure 7**). 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. Makeup transfers were documented at the upper right quadrant of the air bag face along with lipstick transfers to the lower right quadrant. Multiple vinyl transfers were also identified at the upper right quadrant on the rear aspect of the air bag from expansion within the module. The vehicle was also equipped with a driver's seat track positioning sensor. This driver was seated within a 10.2 cm (4.0 in) zone of full forward, therefore, the frontal air bag system's first stage only deployed.



**Figure 6. 2000 Ford Taurus LX deployed frontal air bags.**

The front right passenger air bag was identified by the following part number: \*TS02081N1172\* with a bar coded lot number of: \*P5202880-00A\*. 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. No contact



evidence was identified on the air bag or exterior surface of the module cover flap. The cover flap was rectangular in shape and measured 27.7 cm (10.9 in) in width and 9.0 cm (3.5 in) in height. Multiple black vinyl transfers were noted across the face of the air bag from expansion within the module. The passenger air bag measured 57.2 cm (22.5 in) in width and 50.4 cm (19.8 in) in height in its deflated state (**Figure 8**). 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 7. 2000 Ford Taurus LX deployed driver air bag.**



**Figure 8. 2000 Ford Taurus LX deployed 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. The right front side impact air bag deployed as a result of the secondary impact with the Ford pickup truck. The air bag module was identified by the following part number: FAA\*KSR0003249142\*. The “L” shaped air bag membrane measured 34.5 cm (13.6 in) in width and 69.0 cm (27.2 in) in height in its deflated state (**Figure 9**). The bag was tethered by one vertical stitch pattern along the mid-portion of the membrane (no vent ports present). No contact evidence was identified on the air bag.

The driver's restraint system also included a buckle pretensioner mounted longitudinally alongside the seat cushion (**Figure 10**). The activation of this pretensioner resulted in 6.0 cm (2.4 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. The front right seated position was not occupied, therefore, the buckle pretensioner did not fire.



**Figure 9. 2000 Ford Taurus LX deployed right front side impact air bag.**



**Figure 10. Driver restraint activated buckle pretensioner.**

## **DRIVER DEMOGRAPHICS**

Age/Sex: 70 year old female  
Height: 155 cm (61 in)  
Weight: 64 kg (140 lb)  
Seat Track Position: 5.5 cm (2.2 in) aft of the full forward position (*only deployed first stage at this position*)  
Manual Restraint Use: 3-point lap and shoulder belt system  
Usage Source: Vehicle inspection, driver interview, police report  
Eyewear: Prescription glasses  
Type of Medical Treatment: Transported to a local hospital and released

### **Driver Injuries**

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
Small laceration posterior left forearm	Minor (790602.1,2)	Unknown source

### **Driver Kinematics**

The 70 year old female driver of the 2000 Ford Taurus LX 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 mid-to-forward position. Her hands were placed at the 10 o'clock and 3 o'clock positions on the steering wheel rim. Belt usage was confirmed by the lack of significant injury and activation of the pretensioner system.

At impact, the driver initiated a forward and slightly lateral trajectory in response to the 1 o'clock impact force and loaded the manual restraint and deployed driver air bag. Contact to the deployed air bag was confirmed by the makeup transfers documented to the face of the air bag membrane. Although the driver complained to police of pain to the chest and stomach, she disclosed to the SCI investigator only a small laceration to the posterior aspect of the left forearm from contact to an unknown component. She subsequently initiated a lateral trajectory in response to the 3 o'clock impact force and probably loaded the center armrest with no resulting injury reported. The driver was transported by ambulance to a local hospital for treatment and released. The Advanced Occupant Protection System provided additional protection against further contact to the steering wheel hub/rim, and potential serious injury.

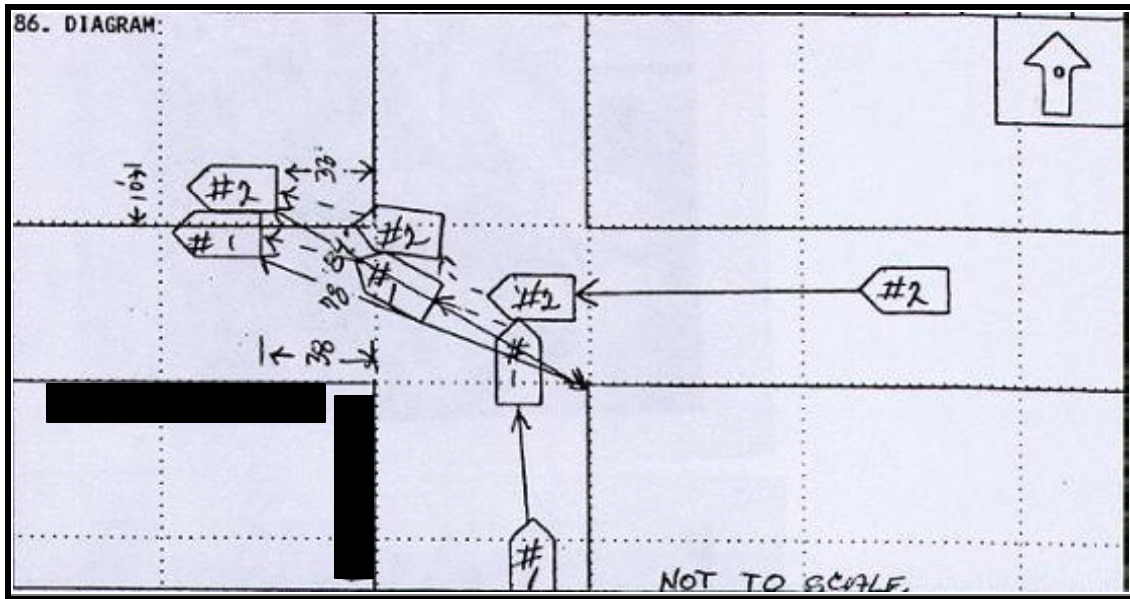


Figure 11. Police Report Scene Diagram.

CA00-042.hex

2000 Taurus/Sable EDR Report - Summary Page

Investigation Data

File Name:	CA00-042.hex	File Save Date:	11-Oct-2000
File Read-out Date:	N/A	Report Date:	11-Dec-2000
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:	22		
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:	20
Time From Algorithm Wakeup to First Stage - Unbelted:	38
Time From Algorithm Wakeup to First Stage - Belted:	41
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:	Yes
Passenger Seat Weight Switch Position:	N/A

Deployment Initiation Attempt Times

	Driver	Passenger
Time From Algorithm Wakeup to Pretensioner Deployment Attempt:	20	Unbelted
Time From Algorithm Wakeup to First Stage Deployment Attempt:	38	38
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Disposal	Disposal

Notes

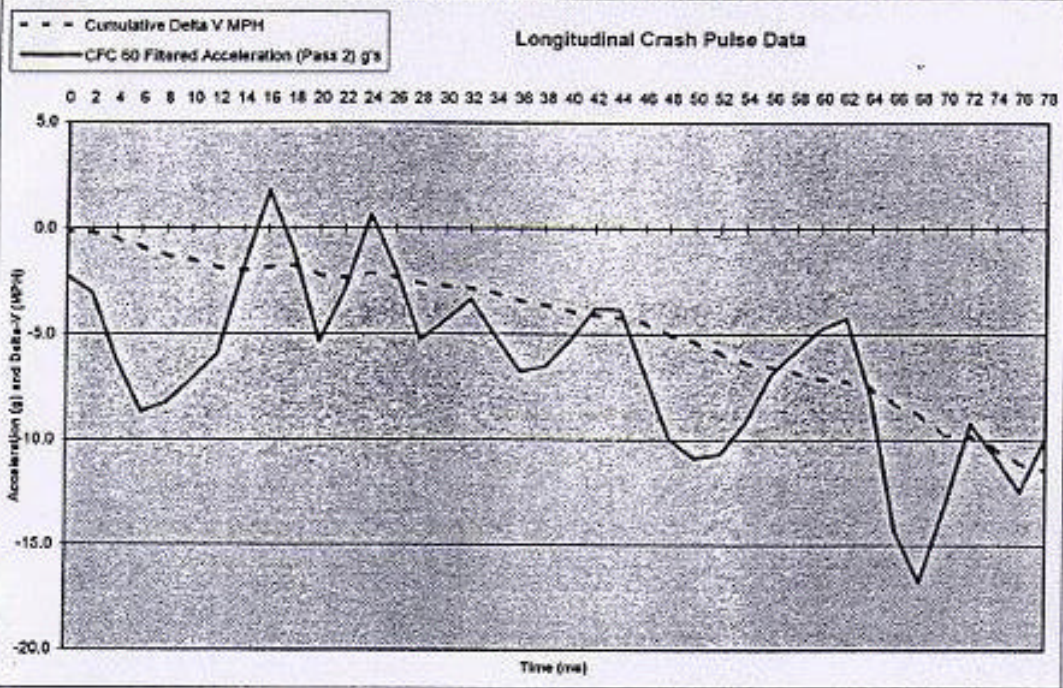
1. Read-out date is set by the PC interface tool.
2. Features and data parameters which are not available on the module are marked "N/A".
3. CFC 80 is a Butterworth 4-pole phaseless digital filter. (See SAE J211 Part 1 Appendix C dated March 1995.)
4. Total and maximum Delta-V results are not available 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.
7. Acceleration data and plots are only valid for frontal impact event recordings.

Figure 12. 2000 Ford Taurus LX EDR report.

### Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	-0.1	-1.5	-2.2	-2.7	-3.9	-5.4	-7.2	-9.8	-11.5

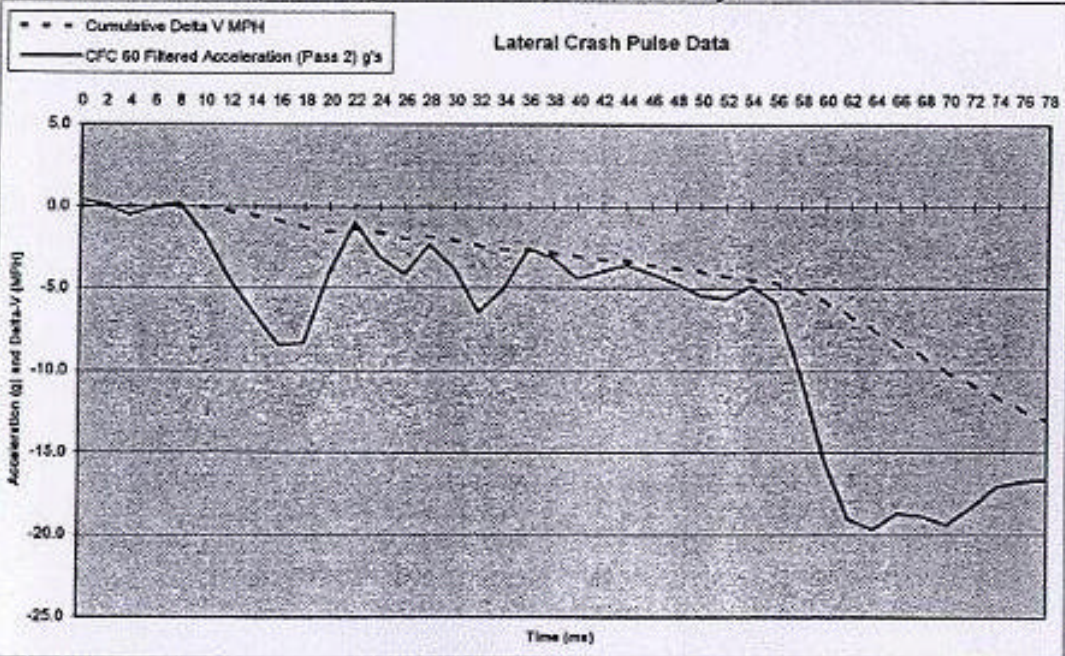
Note: Acceleration data and plots are only valid for frontal impact event recordings.



### Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.0	0.0	-1.6	-2.0	-3.0	-4.0	-5.8	-10.1	-13.1

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



File Name: CA00-042.hex

Figure 13. 2000 Ford Taurus LX EDR report.