

**TRANSPORTATION SCIENCES
CRASH DATA RESEARCH CENTER**

Veridian Engineering
Buffalo, New York 14225

**VERIDIAN ON-SITE ADVANCED OCCUPANT PROTECTION
SYSTEM (AOPS) INVESTIGATION**

VERIDIAN CASE NO. CA02-011

VEHICLE - 2000 FORD TAURUS SE

LOCATION - STATE OF TEXAS

CRASH DATE - FEBRUARY, 2002

Contract No. DTNH22-01-C-17002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
Washington, D.C. 20590

DISCLAIMER

This document is disseminated under the sponsorship of the Department of Transportation in the interest of information exchange. The United States Government assumes no responsibility for the contents or use thereof.

The opinions, findings, and conclusions expressed in this publication are those of the authors and not necessarily those of the National Highway Traffic Safety Administration.

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.

TECHNICAL REPORT STANDARD TITLE PAGE

1. <i>Report No.</i> CA02-011	2. <i>Government Accession No.</i>	3. <i>Recipient's Catalog No.</i>	
4. <i>Title and Subtitle</i> Veridian On-Site Advanced Occupant Protection System (AOPS) Investigation Vehicle - 2000 Ford Taurus SE Location - State of Texas		5. <i>Report Date:</i> November, 2002	
7. <i>Author(s)</i> Crash Data Research Center		6. <i>Performing Organization Code</i>	
9. <i>Performing Organization Name and Address</i> Veridian Engineering Transportation Sciences Crash Data Research Center P.O. Box 400 Buffalo, New York 14225		8. <i>Performing Organization Report No.</i>	
12. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, D.C. 20590		10. <i>Work Unit No.</i> C00410.0000.0026	
15. <i>Supplementary Notes</i> On-site investigation of an offset frontal collision that involved a 2000 Ford Taurus SE 4-door sedan equipped with the Advanced Occupant Protection System (AOPS).		11. <i>Contract or Grant No.</i> DTNH22-01-C-17002	
16. <i>Abstract</i> This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) of a 2000 Ford Taurus SE 4-door sedan. The 2000 Ford Taurus was equipped with buckle pretensioners, (seat mounted) side impact and dual stage frontal air bags for the driver and front right passenger positions. The frontal air bags deployed as a result of an offset frontal collision with a 1990 Ford F-150 pickup truck. The driver of the 1990 Ford pickup truck was operating the vehicle westbound on approach to a 4-leg rural intersection when he allowed the vehicle to cross the centerline and into the path of the eastbound Ford Taurus. As the Ford pickup truck entered the eastbound lane, the front left area impacted the front left area of the Ford Taurus resulting in moderate damage to both vehicles. The restrained 17 year old female driver of the 2000 Ford Taurus SE initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint. The Ford Taurus driver refused subsequent transport and diagnosis of police reported possible injury.		13. <i>Type of Report and Period Covered</i> Technical Report Crash Date - February, 2002	
17. <i>Key Words</i> Collision Deformation Classification (CDC): 12FLEE4 WinSMASH damage algorithm: 18.0 km/h (11.2 mph) Advanced Occupant Protection System (AOPS) Proper use of the manual belt system		14. <i>Sponsoring Agency Code</i>	
19. <i>Security Classif. (of this report)</i> Unclassified		18. <i>Distribution Statement</i> General Public	
20. <i>Security Classif. (of this page)</i> Unclassified		21. <i>No. of Pages</i> 9	22. <i>Price</i>

TABLE OF CONTENTS

BACKGROUND	1
SUMMARY	
Crash Site	1
Pre-Crash	1
Crash	2
Post-Crash	2
VEHICLE DATA	2
VEHICLE DAMAGE	
Exterior	3
Interior	3
MANUAL RESTRAINT SYSTEMS	3
ADVANCED OCCUPANT PROTECTION SYSTEM (AOPS)	4
Event Data Recorder (EDR)	5
DRIVER DEMOGRAPHICS	6
Driver Injuries	6
Driver Kinematics	6
SCENE DIAGRAM	7
2000 FORD TAURUS SE EVENT DATA RECORDER (EDR) REPORT	8

**VERIDIAN ON-SITE ADVANCED OCCUPANT PROTECTION
SYSTEM (AOPS) INVESTIGATION
VERIDIAN CASE NO. CA02-011
VEHICLE - 2000 FORD TAURUS SE
LOCATION - STATE OF TEXAS
CRASH DATE - FEBRUARY, 2002**

BACKGROUND

This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) of a 2000 Ford Taurus SE 4-door sedan. The 2000 Ford Taurus was equipped with buckle pretensioners, (seat mounted) side impact and dual stage frontal air bags for the driver and front right passenger positions. The frontal air bags deployed as a result of an offset frontal collision with a 1990 Ford F-150 pickup truck. The driver of the 1990 Ford pickup truck was operating the vehicle westbound on approach to a 4-leg rural intersection when he allowed the vehicle to cross the centerline and into the path of the eastbound Ford Taurus. As the Ford pickup truck entered the eastbound lane, the front left area impacted the front left area of the Ford Taurus resulting in moderate damage to both vehicles. The restrained 17 year old female driver of the 2000 Ford Taurus SE initiated a forward trajectory in response to the 12 o'clock impact force and loaded the manual restraint. The Ford Taurus driver refused subsequent transport and diagnosis of police reported possible injury.

The crash was identified by the National Highway Traffic Safety Administration (NHTSA) through a search of the General Estimates System (GES) police report database. Due to the deployment of the Advanced Occupant Protection System, the crash was assigned to the Veridian SCI team as an on-site investigative effort on Tuesday, March 25, 2002. Although slight delays were incurred locating the subject vehicle and establishing cooperation, activities for this investigation were completed Wednesday, April 17, 2002.

SUMMARY

Crash Site

This two vehicle crash occurred during the early evening hours of February, 2002. At the time of the crash, it was daylight with no adverse conditions as the roads were dry. The crash occurred in the eastbound lane of a (straight and level) two lane, 4-leg rural intersection which was controlled by yield signs for north/southbound traffic (see **Figure 8 - page 7**). The asphalt surfaced intersection was bordered by 1.2 meter (3.9 feet) gravel shoulders. Environmental features included private residences and a vacant lot in the northeast sector of the intersection. The posted speed limit at the crash site was 48 km/h (30 mph).

Pre-Crash

The 40 year old male driver of the 1990 Ford F-150 pickup truck was operating the vehicle westbound (**Figure 1**) at a (police reported) unknown speed, and on approach to the rural 4-leg intersection. For unknown reasons, the driver allowed the vehicle to cross the centerline and into the path of the eastbound Ford Taurus. The police reported no tire marks at the scene indicative of driver avoidance maneuvers.

The 17 year old female driver of the 2000 Ford Taurus SE was operating the vehicle eastbound (**Figure 2**) at a (police reported) unknown speed and on approach to the 4-leg intersection. Anticipation of the crash was unknown as the vehicle proceeded straight through the intersection, and remained in the eastbound lane prior to the collision.

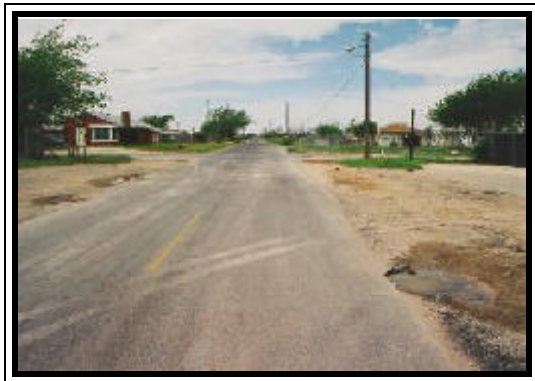


Figure 1. Westbound approach for the 1990 Ford F-150 pickup truck.



Figure 2. Eastbound approach for the 2000 Ford Taurus SE.

Crash

As the Ford pickup truck crossed the centerline of the two lane roadway, the front left area impacted the front left area of the Ford Taurus resulting in moderate damage to both vehicles. The lack of exact specifications on the Ford pickup truck invalidated the use of the missing vehicle algorithm of the WinSMASH reconstruction program. However, a barrier equivalent velocity change of 18.0 km/h (11.2 mph) was computed for the subject vehicle, with a longitudinal component of -17.8 km/h (-11.1 mph). The impact induced deceleration was sufficient to deploy the Ford's Advanced Occupant Protection System. The Ford's Restraint Control Module (RCM) recorded a longitudinal element of -51.8 km/h (-32.2 mph) at the 30 millisecond interval *as a second stage deployment* (see **Figures 9 - 12, page 8**). The 2000 Ford Taurus SE rotated counterclockwise and came to rest in the southeast sector of the intersection facing northeast, as the 1990 Ford F-150 pickup truck came to rest in the northwest sector of the intersection facing southwest.

Post-Crash

The exit status of both drivers were unknown, however, the Ford pickup truck driver was reported by police as uninjured in the collision as the Ford Taurus driver refused subsequent transport and diagnosis of possible injury. Both vehicles were towed from the crash site due to disabling damage.

VEHICLE DATA

The 2000 Ford Taurus SE was manufactured in February, 2000 and identified by the vehicle identification number (VIN): 1FAFP53U5YA (production number deleted). An acquaintance of the driver (relationship unknown) was reported by police as the owner of the vehicle. The vehicle was a 4-door sedan equipped with power windows/door locks/driver seat, front-wheel drive, and a 3.0 liter, V-6 engine. At the time of the crash, the odometer had recorded 73,724 km (45,811 miles). The seating was configured with front bucket and rear bench seats. Adjustable pedals were not present in the vehicle. The driver and owner could not be located for the SCI interview, therefore, previous crashes or maintenance on the Ford's Advanced Occupant Restraint System were unknown.

VEHICLE DAMAGE

Exterior

The 2000 Ford Taurus SE sustained moderate frontal damage as a result of the impact with the 1990 Ford F-150 pickup truck (**Figure 3**). The direct contact damage began at the front left bumper corner and extended 27.0 cm (10.6 in) inboard. The impact deformed the entire front end width resulting in a combined direct and induced damage length (Field L) of 133.0 cm (52.4 in). Six crush measurements were documented at the level of the reinforcement bar (*bumper fascia separation*): C1= 28.0 cm (11.0 in), C2= 12.5 cm (4.9 in), C3= 7.5 cm (3.0 in), C4= 2.5 cm (1.0 in), C5= 0 cm, C6= 0 cm. The Collision Deformation Classification (CDC) assigned for this impact to the Ford was 12-FLEE-4 with a principal direction of force of (-)10 degrees. The hood was deformed slightly up and rearward from the impact force. Direct contact damage was also identified on the left front side surface and attributed to spin-out contact following initial engagement. This direct damage began at the front left bumper corner and extended rearward 91.0 cm (35.8 in). The left fender was deformed rearward which partially restricted the right front wheel/tire (not deflated). No wheelbase reduction was identified. The windshield was fractured at the left lower A-pillar from exterior impact forces only. All tempered glazing remained undamaged.



Figure 3. Front left damage to the 2000 Ford Taurus SE.

Interior

No damage was identified to the interior surfaces of the Ford Taurus from occupant contact or component intrusions.

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 (inertial lock/belt sensitive). Dimpling was documented on the shoulder portion of the driver restraint along with abrading to the latchplate webbing sleeve, which was attributed to latchplate loading (**Figure 4**). The front right (and rear) seating position was equipped with a 3-point manual lap and shoulder belt system which consisted of a continuous loop belt webbing with a sliding latchplate and a retractor equipped with an inertial and switchable lock mechanism.

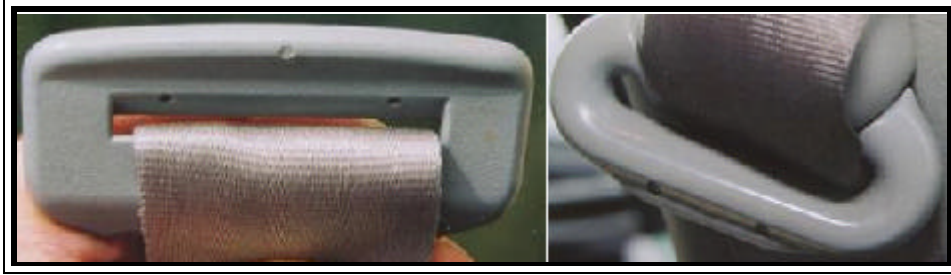


Figure 4. Loading evidence to the driver restraint.

ADVANCED OCCUPANT PROTECTION SYSTEM (AOPS)

The 2000 Ford Taurus SE was equipped with dual stage frontal air bags for the driver and front right passenger positions which deployed as a result of the crash (**Figure 5**). The driver air bag was identified by the Ford part number: 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 7.5 cm (3.0 in) in height while the lower flap measured 16.5 cm (6.5 in) in width and 5.5 cm (2.2 in) in height. No contact evidence was identified on the exterior surface of the module cover flaps, however, elongated black vinyl transfers were identified at the right lower quadrant of the air bag face from expansion within the module. The diameter of the driver air bag measured 54.5 cm (21.5 in) in its deflated state. The bag was tethered by two internal straps and vented by two 3.2 cm (1.3 in) ports located at the 11 o'clock and 1 o'clock sectors on the rear aspect of the air bag. Rearward air bag excursion measured 27.5 cm (10.8 in) from the steering wheel hub. The vehicle was also equipped with a driver's seat track positioning sensor. The driver was not seated within a 10.2 cm (4.0 in) zone of full forward, therefore, the frontal air bag system's second stage deployed. It should be noted that the driver's seat track was found at the full rearward position (*no vehicle power*) at the time of the SCI inspection. The lack of driver height and weight prevents determination of the exact seat track position.

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 passenger air bag was identified by the Ford part number: P5202880-00A with a bar coded lot number of: *TS0202N0403*. The flap was rectangular in shape and measured 27.6 cm (10.9 in) in width and 14.5 cm (5.7 in) in height. No contact evidence was



Figure 5. 2000 Ford Taurus SE deployed redesigned frontal air bags.

identified on the exterior surface of the module cover flap, however, multiple black vinyl transfers were noted across the lower portion of the bag face from expansion within the module. The passenger air bag measured 58.8 cm (23.1 in) in width and 53.0 cm (20.9 in) in height in its deflated state. The bag was vented by two 5.4 cm (2.1 in) diameter ports located at the 10 o'clock and 2 o'clock sectors on the side aspect of the bag. No internal tether straps were present. Rearward bag excursion measured 51.0 cm (20.1 in) from the aft portion of the right instrument panel.

The Ford was also equipped with seat-mounted side impact air bags for the front seated positions. The side impact air bags did not deploy as a result of the crash. The air bag modules were housed in the outboard side aspect of the front seat backs [20.0 cm (7.9 in) above the level of the seat cushion] with a single cover flap design. The side impact air bag sensors were located in the front door cavities.

The front restraint systems also included buckle pretensioners mounted longitudinally alongside the seat cushions (**Figure 6**). The activation of the driver side pretensioner resulted in 57.0 millimeters (2.2 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 seating position was not occupied, therefore, the buckle pretensioner did not fire.



Figure 6. 2000 Ford Taurus SE deployed driver and non-deployed front right buckle pretensioners.

Event Data Recorder (EDR)

The 2000 Ford Taurus SE Restraints Control Module (RCM) was located under the center instrument panel area as the event data was retrieved via the J1962 connector found to the left of the steering column. The Event Data Recorder (EDR) records deployment events for the AOPS. In this crash, the EDR recorded a *non-deployment* with a longitudinal (element) velocity change of -51.8 km/h (-32.2 mph) at the 30 millisecond interval. The system status at deployment reflected the driver's belt switch circuit status as "unbuckled".

DRIVER DEMOGRAPHICS

Age/Sex: 17 year old female
Height: Unknown
Weight: Unknown
Seat Track Position: Mid-to-rear position
Manual Restraint Use: 3-point lap and shoulder belt
Usage Source: Vehicle inspection, police report
Eyeware: Unknown
Type of Medical Treatment: Refused

Driver Injuries

<i>Injury</i>	<i>Severity (AIS 90)</i>	<i>Injury Mechanism</i>
*Unknown	N/A	N/A

**police reported possible injury*

Driver Kinematics

The 17 year old female driver of the 2000 Ford Taurus SE was restrained by the available 3-point manual lap and shoulder belt system, and seated in an upright posture with the seat track adjusted to an approximated mid-to-rear position (**Figure 7**). Contrary to the vehicle’s EDR summary, belt usage was evidenced by the loading marks documented on the webbing and D-ring of the driver restraint.

At impact, the driver initiated a forward trajectory in response to the 12 o’clock impact force and loaded the manual restraint. The lack of contact evidence to the deployed dual stage air bag suggested limited or no driver interaction in this moderate severity collision. Possible injury information was unknown as the SCI interview was not obtained, however, the driver of the 2000 Ford Taurus SE refused subsequent transport to a local medical facility for diagnosis and treatment of police reported possible injury. The Advanced Occupant Restraint System provided additional protection against further contact to the steering wheel hub/rim, and potential serious injury.



Figure 7. Interior view of the driver space.

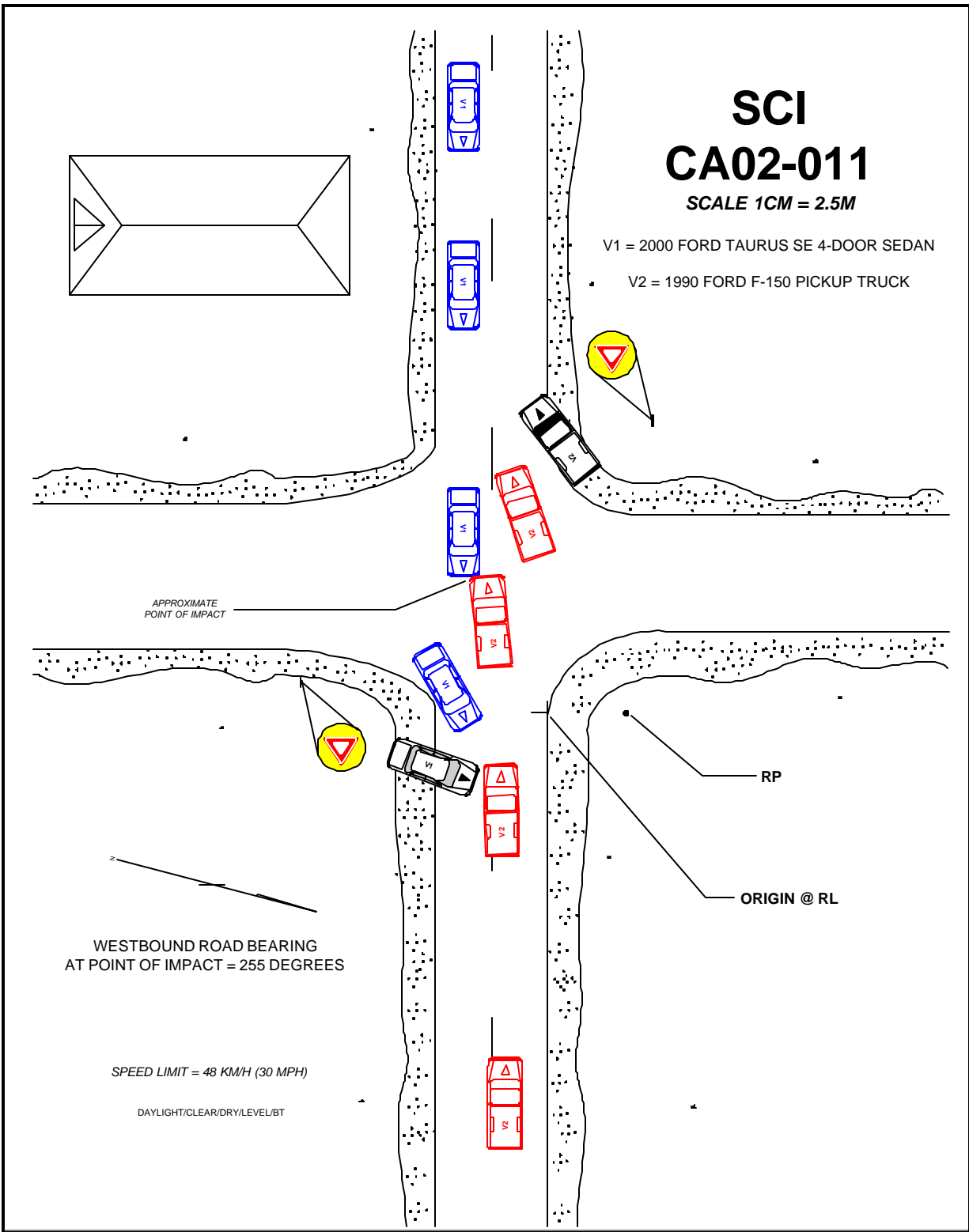


Figure 8. Scene Diagram.

1CAF053[REDACTED] System Status At Non-Deployment	
Vehicle Integrity Check	Pass
EDR Module Version	41
Time From Side Safety Decision to Luff (Driver) Side Bag Deployment (msec)	Not Deployed
Time From Side Safety Decision to Ruff (Passenger) Side Bag Deployment (msec)	Not Deployed
Logic Code Update - HEC7 Pin Event Cleared	0
Time From Algorithm Wakeup to Pretensioner (msec)	0
Time From Algorithm Wakeup to First Stage - Unlashed (msec)	0
Time From Algorithm Wakeup to First Stage - Latched (msec)	1
Time From Algorithm Wakeup to Second Stage (msec)	0
Driver Seat Belt Buckle	Not Engaged
Passenger Seat Belt Buckle	Not Engaged
Driver Seat Forward Postion	Not
Routine (msec)	30
Number of Incomplete Recordings	0

Parameter	Driver	Passenger
Time From Algorithm Wakeup to Pretensioner Deployment Attempt (msec)	Not Deployed	Not Deployed
Time From Algorithm Wakeup to First Stage Deployment Attempt (msec)	Not Deployed	Not Deployed
Time From Algorithm Wakeup to Second Stage Deployment Attempt (msec)	Not Deployed	Not Deployed

Figure 9. 2000 Ford Taurus SE EDR report.

Time (msec)	Long. Acceleration (Gs)	Long. Cumulative Delta V (MF/L)	Lat. Acceleration (Gs)	Lat. Cumulative Delta V (MF/L)
0	0	0	.00	0
2	0	0	.00	0
4	.57	0	.48	0
6	.57	0	.46	0
8	3.52	0	2.81	0
10	3.44	0	2.76	0
12	-20.45	0	-10.29	0
14	-31.07	-8.55	-46.71	-2.85
16	-37.84	-7.5	-67.75	-5.7
18	-35.03	-10.74	-67.81	-8.55
20	-60.83	-17.31	-64.54	-11.42
22	-60.83	-17.89	-64.52	-14.27
24	61.8	21.47	65.08	17.12
26	61.8	25.05	65.08	19.98
28	51.48	28.63	64.99	22.83
30	-51.48	-32.21	-64.99	-25.69

Figure 10. 2000 Ford Taurus SE EDR report.

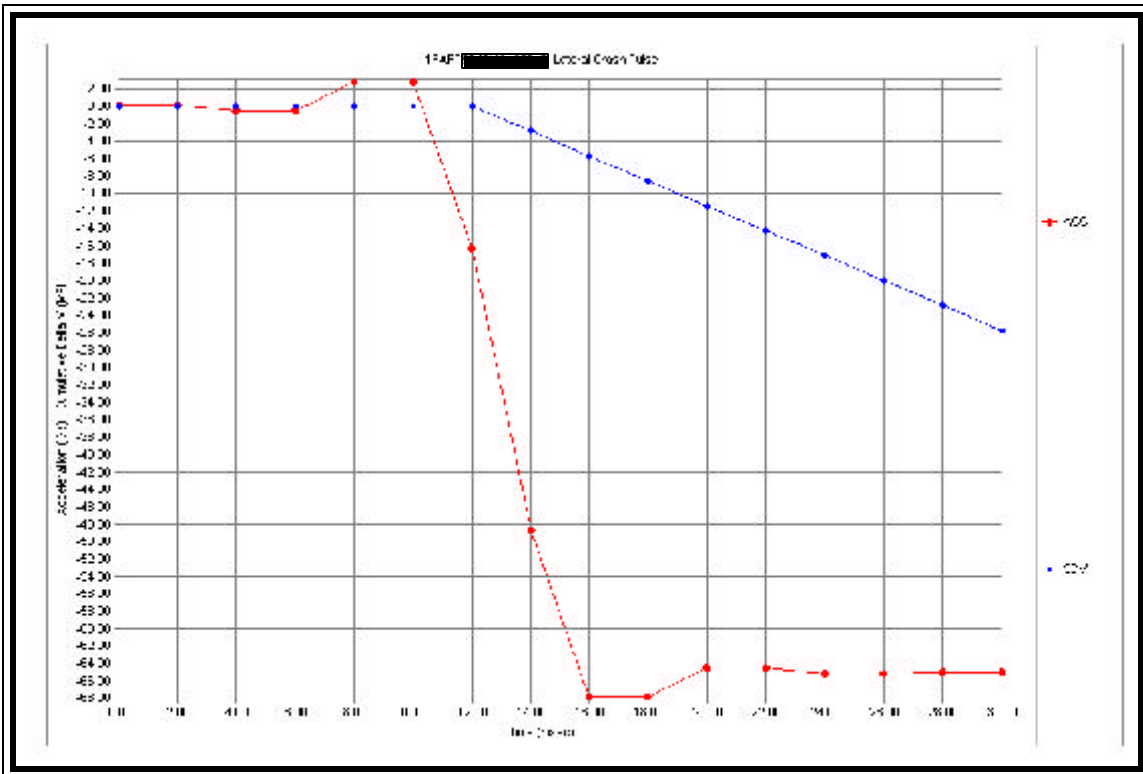


Figure 11. 2000 Ford Taurus SE EDR report.

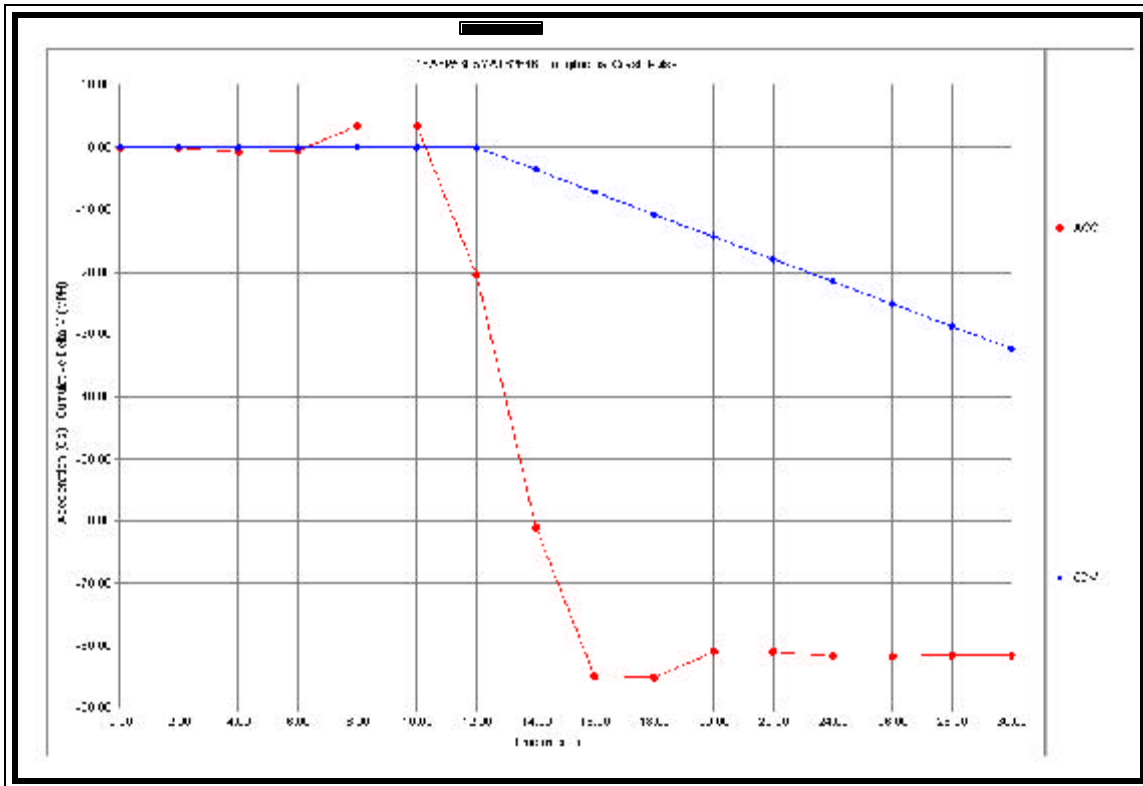


Figure 12. 2000 Ford Taurus SE EDR report.