

Advanced Occupant Protection Systems On-scene Investigation  
Dynamic Science, Inc. / Case Number: DS01-006  
2000 Ford Taurus SES 4-door  
California  
December, 2000

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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 crash-worthiness performance of the involved vehicle(s) or their safety systems.*

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16. Abstract  <p>This case was initiated because the case vehicle was equipped with an Event Data Recorder (EDR) and Advanced Occupant Protection System (AOPS). The collision occurred in southern California in December, 2000 at 1145 hours. This was a single vehicle versus a concrete street lamp pole, a tree and then a rollover type collision. The collision occurred on a four-lane, two-way, undivided roadway. The case vehicle is a 2000 Ford Taurus SES 4-door driven by a 70-year-old female (160 cm-63 in./57 kg-125 lbs). The case vehicle was traveling northbound in the left lane. The driver of the case vehicle was unaware of a pre-existing medical condition of heart arrhythmia. She lost consciousness and the case vehicle veered to the left into on-coming southbound travel lanes, departed the roadway, and traveled on the west sidewalk area. The case vehicle collided head-on into a concrete lamp pole (overlapping CDC). The frontal air bags in the case vehicle probably deployed at this time. The vehicle continued traveling northbound off the roadway approximately 7 meters (23 ft) and collided head-on (12FDEW3) with a tree. The case vehicle bounced off the tree and rolled over onto its top, having rotated ninety degrees. It came to final rest heading east approximately 2.7 meters (9 ft) north of the impact with the tree. Both the concrete lamp pole and the tree were knocked down and uprooted with the tree falling on a parked 1989 GMC U.S. postal vehicle. The case vehicle was towed from the scene due to damage and subsequently declared a total loss and sold as salvage.</p> <p>The impact with the concrete street lamp post and tree were overlapping damage. Frontal crush measurements were taken and a Collision Deformation Classification(CDC) entered for the second impact with the tree. It is assumed that the impact with the tree was the severest damage. The case vehicle was assigned a CDC of 12FDEW3 with a Principle Direction of Force (PDOF) of 000 degrees. The Delta V for the case vehicle was computed using WinSmash version 2.12 and the pole option. WinSmash calculated a total delta v of 33.0 km/h (20.5 mph), a longitudinal delta v of -33.0 km/h (-20.5 mph), and a latitudinal delta v of 0.0 km/h (0.0 mph). The downloaded EDR data indicates a cumulative longitudinal delta v of -35.2 km/h (-21.9 mph) at the 70 ms mark. Due to the overlapping damage and the yielding object, the WinSmash results are borderline.</p> <p>The driver could not remember anything about the collision. She indicated that she lost consciousness and came to in the vehicle upside down and held in place by the lap and shoulder belt. She was transported to a trauma center via ambulance. She sustained a contusion to the right side of her face as a result of contact with the driver's air bag. There was evidence of contact to the driver's air bag with makeup and lipstick transfers to the front center area. She sustained a contusion to her stomach from the seat belt. She also complained of pain to her back, knees and chest. She indicated she had a preexisting medical condition concerning her back, but was not aware of the heart arrhythmia. She was hospitalized for five days and diagnosed with the heart arrhythmia.</p>					
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**Dynamic Science, Inc.  
Accident Investigation  
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**BACKGROUND:**

**Description:** This Event Data Recorder (EDR) and Advanced Occupant Protection Systems (AOPS) case was reported to the NHTSA by DSI on March 20, 2001 and the case was assigned on March 21, 2001. An on-site investigation was conducted. All field work was completed on February 02, 2002.

**Investigation Type:** On-scene

**Crash Location:** California

**Crash Date:** December, 2000

**Notification Date:** March 20, 2001

**Field Work Completed:** February 02, 2002

**SUMMARY:**

The collision occurred in southern California in December, 2000 at 1145 hours. This was a single vehicle versus a concrete street lamp pole, a tree and then a rollover type collision. The collision occurred on a four-lane, two-way, undivided roadway. The north and southbound roadways are comprised of two travel lanes in each direction. The northbound roadway is straight with a positive 3.8% grade. At the area of impact the north and south roadway intersect an east-west roadway that did not play a role in the collision. The weather was clear and the bituminous roadway surface was dry. The posted speed limit was 56 km/h (35 mph).



**Figure 1.** Approach to impact areas–north.

The case vehicle is a 2000 Ford Taurus SES 4-door driven by a 70-year-old female (160 cm-63 in./57 kg-125 lbs). The case vehicle was traveling northbound in the left lane. The driver of the case vehicle was unaware of a pre-existing medical condition of heart arrhythmia<sup>1</sup>. She lost consciousness and the case vehicle veered to the left into on-coming southbound travel lanes, departed the roadway, and traveled on the west sidewalk area. The case vehicle collided head-on into a concrete lamp pole (overlapping CDC). The frontal air bags in the case vehicle probably deployed at this time. The vehicle continued traveling northbound off the roadway approximately 7 meters (23 ft) and collided head-on (12FDEW3) with a tree. The case vehicle climbed over the

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<sup>1</sup> Excessively slow heart rhythms cause the cardiac output to be insufficient, and this can cause symptoms of fatigue, weakness, lightheadedness, fainting, shortness of breath.

tree and rolled over onto its top about its longitudinal axis, and rotated ninety degrees clockwise. It came to final rest heading east approximately 2.7 meters (9 ft) north of the impact with the tree. Witnesses reported to police that a minor fire started in the engine compartment and that it was extinguished with a fire extinguisher. Both the concrete lamp pole and the tree were knocked down and uprooted with the tree falling on a parked 1989 GMC U.S. postal vehicle.

The impact with the concrete street lamp post and tree were overlapping damage. Frontal crush measurements were taken and a Collision Deformation Classification (CDC) entered for the

second impact with the tree. It is assumed that the impact with the pole caused the airbags in the case vehicle to deploy, and the second impact with the tree was the severest damage (highest delta v). The case vehicle was assigned a CDC of 12FDEW3 for the second impact, with a Principle Direction of Force (PDOF) of 000 degrees. The combined direct and induced damage width was 95.0 cm (37.4 in.) [CRASH L = 148 cm (58.3 in.)], and the maximum crush depth was 66.5 cm (26.2 in.) located at C<sub>4</sub>. The Delta V for the case vehicle was computed using WinSmash version 2.12 and the pole option with stiffness coefficients provided by



**Figure 2.** Rollover damage to case vehicle.

Ford of a 20 cm (8 in.) center pole crash. The Ford stiffness coefficients provided reasonable WinSmash delta v results. WinSmash calculated a total delta v of 33.0 km/h (20.5 mph), a longitudinal delta v of -33.0 km/h (-20.5 mph), and a latitudinal delta v of 0.0 km/h (0.0 mph). The results are borderline due to the overlapping damage and the yielding objects. The results are presented in this report as a reference but were not coded in the EDCS. The downloaded EDR data indicates a cumulative longitudinal delta v of -35.2 km/h (-21.9 mph) at the 70 ms mark.

The case vehicle was towed from the scene due to damage and subsequently declared a total loss and sold as salvage.

The driver could not remember anything about the collision. She indicated that she lost consciousness and came to in the vehicle upside down and held in place by the lap and shoulder belt. She was transported to a trauma center via ambulance. She sustained a contusion to the right side of her face as a result of contact with the driver's air bag. There was evidence of contact to the driver's air bag with makeup and lipstick transfers to the front center area. She sustained a contusion to her stomach from the seat belt. She also complained of pain to her back, knees and chest. She indicated she had a preexisting medical condition concerning her back, but was not aware of the heart arrhythmia. She was hospitalized for five days and diagnosed with the heart arrhythmia.

Scene Diagram

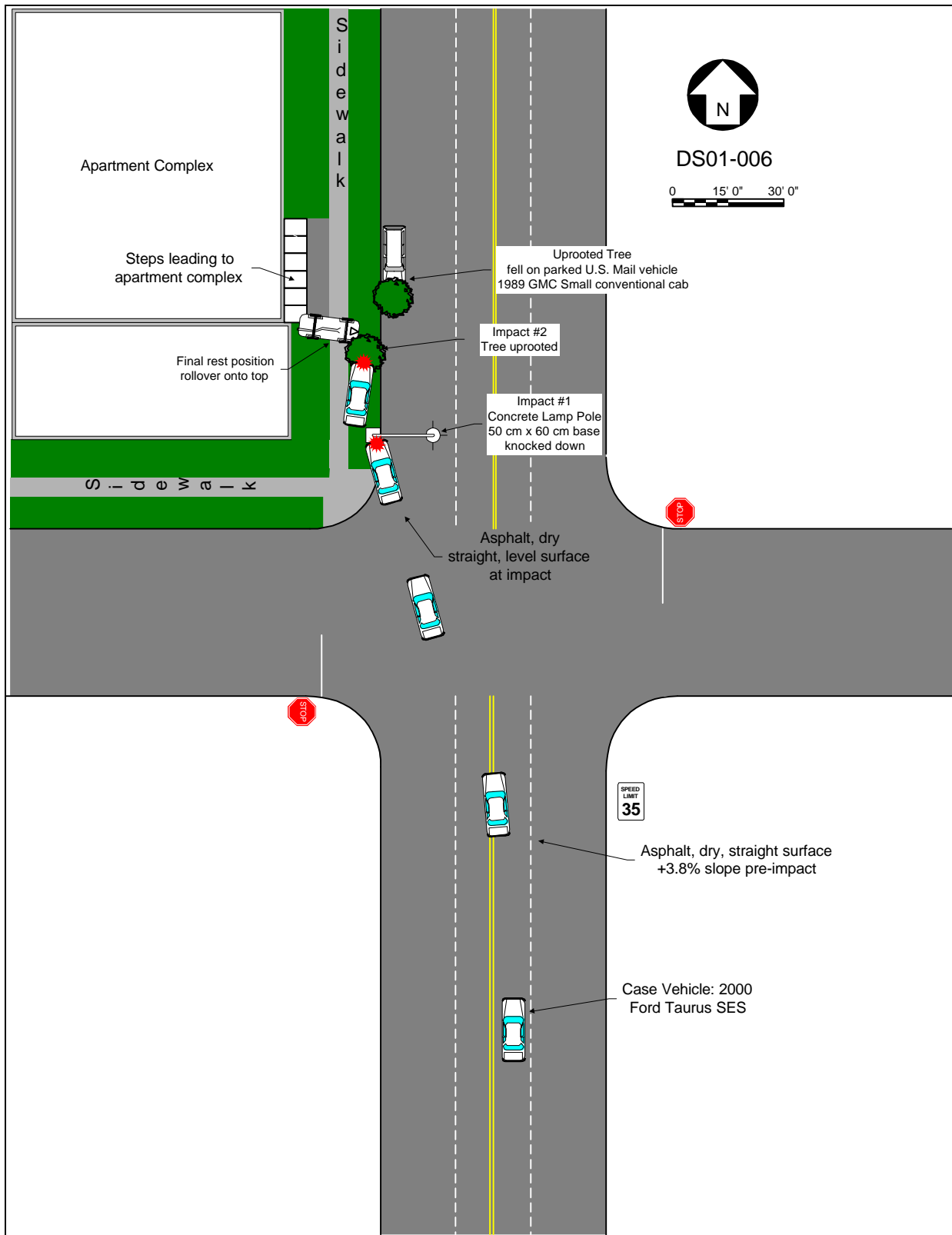


Figure 3. Scene diagram

**DETAILED INFORMATION**

**Vehicles**

Case vehicle

Description: 2000 Ford Taurus SES  
 VIN: 1FAFP55SXYGxxxxxx  
 Odometer: 2,066 km (1,284 miles)  
 Engine: 3.0 L V6  
 Reported Defects: None  
 Cargo: None  
 Damage Description: Severe frontal damage to the bumper, grille, hood, windshield, and top. Small fire reported to have started in engine compartment post impact. Vehicle towed from scene and subsequently declared a total loss and sold as salvage.

CDC:

Impact 1 vs concrete lamp pole Unknown—overlapping damage  
 Impact 2 vs tree 12FDEW3  
 Impact 3 rollover 00TPD03

Delta V for Impact 2 vs tree (highest delta v):

Total	33.0 km/h (20.5 mph)
Longitudinal	-33.0 km/h (-20.5 mph)
Latitudinal	0.0 km/h (0.0 mph)
Energy	72,090 joules (53,171 ft-lbs)



**Figure 4.** Exterior overlapping front damage to the case vehicle.



## AOPS Discussion

This vehicle was equipped with an advanced occupant protection system. The system consists of a Restraint Control Module (RCM) dual stage front air bags, seat belt pretensioners, seat track sensors, and seat belt latch usage detectors. The system is controlled by the RCM. The primary function of the RCM is to control the deployment of the occupant protection systems. The system records longitudinal and lateral acceleration. Data related to the driver and passenger air bag deployment include: 78 milliseconds of crash pulse, deployment strategy of the dual-stage air bag system, seat belt latch use, pretensioner operation, and driver seat track location.

The downloaded EDR data indicates the highest cumulative longitudinal delta v of -21.9 km/h (-35.2 mph) at the 70 ms mark. The EDR report is included as an attachment to this report.

The EDR report further indicates that:

1. This was a first stage deployment.
2. The driver's seat track was in the forward position.
3. The left front seat buckle was engaged and the right front seat buckle was not.
4. The time from algorithm wakeup to pretensioner was 37 milliseconds.
5. The time from algorithm wakeup to first stage - belted was 38 milliseconds.

Note that as a result of driver's seat track in the forward position, the second stage deployment was suppressed.

The case vehicle driver's air bag was circular and measured 44 cm (17.3 in.) in diameter. It was equipped with two tethers and two vent holes at the 11 and 01 o'clock positions. The front center of the air bag there was a driver contact consisting of makeup and a lipstick imprint. The driver's air bag also had dirt from exposure. The dual module covers opened in an "H" configuration.

There were no indications of any damage to driver's air bag or the module covers. The case vehicle front right passenger's air bag was rectangular and measured 42 cm (16.5 in.) high by 48 cm (18.9 in.) wide. It was equipped with two vent ports at the 10 and 02 o'clock positions and was not tethered. There was dirt all over the air bag from exposure. There was no damage to the air bag. The single flap module cover opened properly and was not damaged.

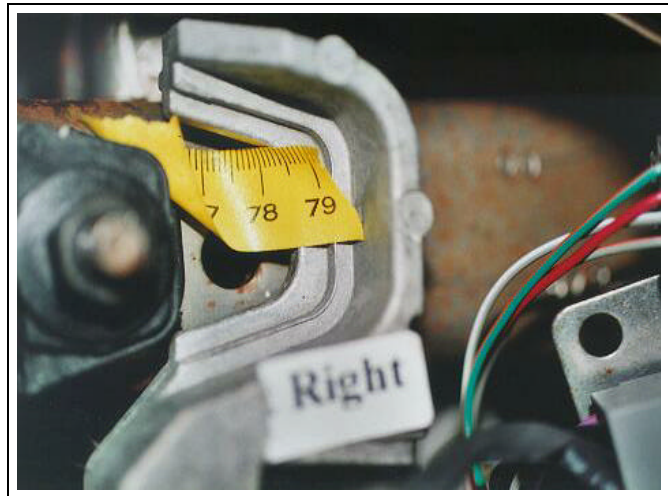
Both front seat positions of the case vehicle were equipped with seat belt buckle pretensioners. The front right pretensioner barrel was checked and measured 11.1 cm (4.4 in.)—indicating that it had not fired. The front left pretensioner barrel was checked and measured 50.0 cm (19.7 in.)—indicating that it had fired.



**Figure 5.** Driver's air bag.

The case vehicle was equipped with power adjustable pedals which were adjusted to within 2.6 cm (1.0 in.) of the rear most position.

The driver loaded the steering column; there was complete separation of the steering column breakaway coupling. The left shear capsule had been stroked 1.7 cm (0.7 in.) and the right capsule had completely separate with the stroke measured as 3.1 cm (1.2 in.).



**Figure 6.** Separation of right shear capsule.

**Occupants**

<u>Case vehicle (Ford Taurus)</u>	Occupant 1
Age/Sex:	70/Female
Seated Position:	Front left
Seat Type:	Gray colored, fabric covered bucket seat. Seat track was adjusted forward most position.
Height:	160 cm (63 in.)
Weight:	57 kg (125 lbs)
Occupation:	Not working
Pre-existing Medical Condition:	Known back problems. She was unaware of heart arrhythmia which was the direct cause of the collision.
Alcohol/Drug Involvement:	None
Driving Experience:	Presumed to be greater than 50 years.
Body Posture:	Unknown due to unconsciousness.
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt available, used. Seat belt found cut and RCM indicated belt buckle was engaged.
Air bag:	Steering wheel mounted air bag, deployed

**Injuries and Injury Mechanisms**Case vehicle (Ford Taurus)

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Contusion to right side of face	290402.1, 1	920	Air bag
	Contusion to stomach	590402.1, 8	922.2	Seat belt
	Pain to back, left knee and ankle–non codeable injuries			

## Occupant Kinematics

The driver of the case vehicle appears to have been unconscious prior to the collision. She was wearing the available manual lap and shoulder belt. The EDR indicates that the driver's seat belt buckle was engaged and the seat belt was found to be cut and there was evidence of loading on the seat belt webbing. The shoulder belt upper anchorage adjustment was in the mid position. The grey colored, fabric-covered bucket seat was adjusted to the forward most track position. The seat back angle was adjusted to a 21 degrees rearward reclined position. The power adjustable pedals were adjusted to within 2.6 cm (1.0 in.) of the rear most position. At impact with the pole, the driver responded to the 0 degrees principal direction of force by moving straight forward. The lap and shoulder belts restricted this forward motion but her legs struck the rigid plastic cover of the instrument panel displacing it slightly. Her face contacted the center of the air bag—there was makeup and lipstick transfer on the front center area. Contact with the air bag caused a contusion to the right side of her face. The case vehicle continued moving forward and struck the tree. The driver responded by moving straight forward and again the lap and shoulder belts restricted this forward motion. As the vehicle rolled over and came to rest on its roof the driver was held in place by the lap and shoulder belt and caused a contusion to her stomach. It is at this point that the driver remember regaining consciousness. She was assisted and removed from the vehicle by bystanders.

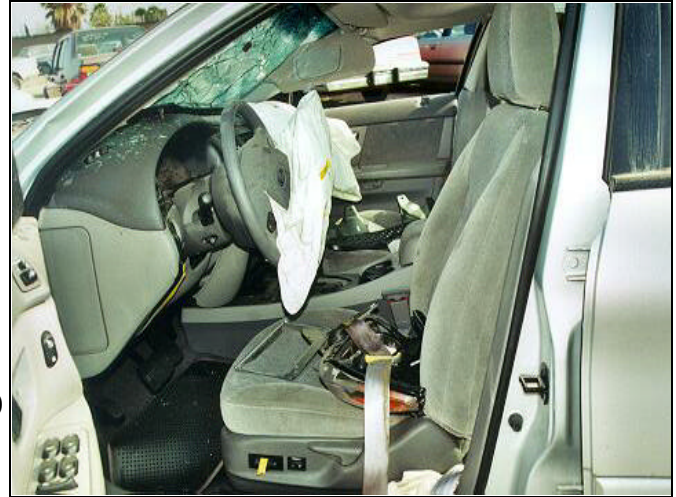


Figure 7. Driver's seat area.

The driver of the case vehicle was transported to a trauma center and was hospitalized for five days. She was diagnosed with the heart arrhythmia.

## Attachment 1. EDR report

## 2000 Taurus/Sable EDR Report - Summary Page

**Investigation Data**

File Name:	ds01-006.hex	File Save Date:	25-Mar-2001
File Read-out Date:	N/A	Report Date:	26-Mar-2001
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:	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:	37
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:	37	Unbelted
Time From Algorithm Wakeup to First Stage Deployment Attempt:	38	38
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Disposal	Disposal

**Notes**

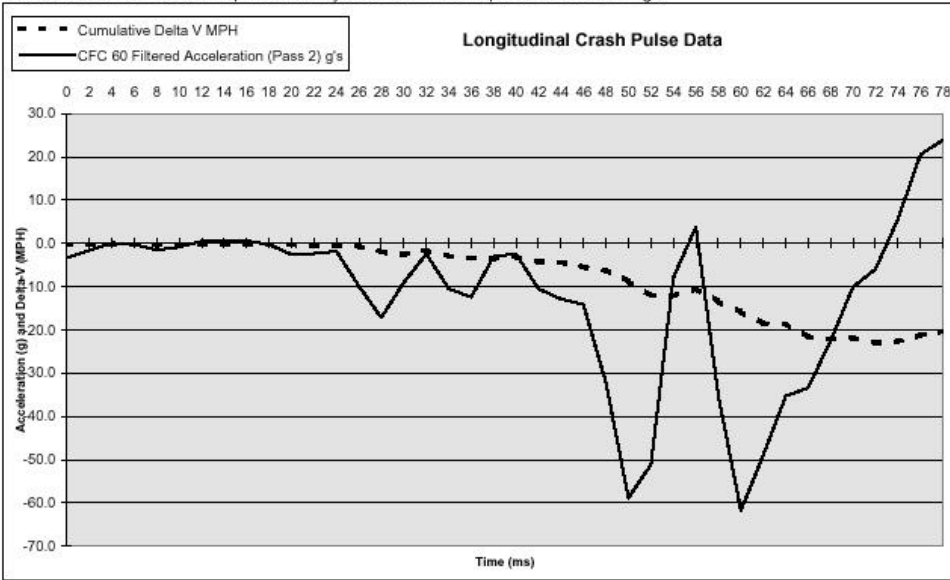
1. Read-out date is set by the PC interface tool.
2. Features and data parameters which are not available on the module are marked "N/A".
3. CFC 60 is a Butterworth 4-pole phaseless digital filter. (See SAE J211 Part 1 Appendix C dated March 1995.)
4. Total and maximum Delta-V results are not available 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.
7. Acceleration data and plots are only valid for frontal impact event recordings.

### 2000 Taurus/Sable EDR Report - Charts

#### Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	-0.2	-0.4	-0.3	-2.6	-3.1	-8.8	-15.9	-21.9	-20.3

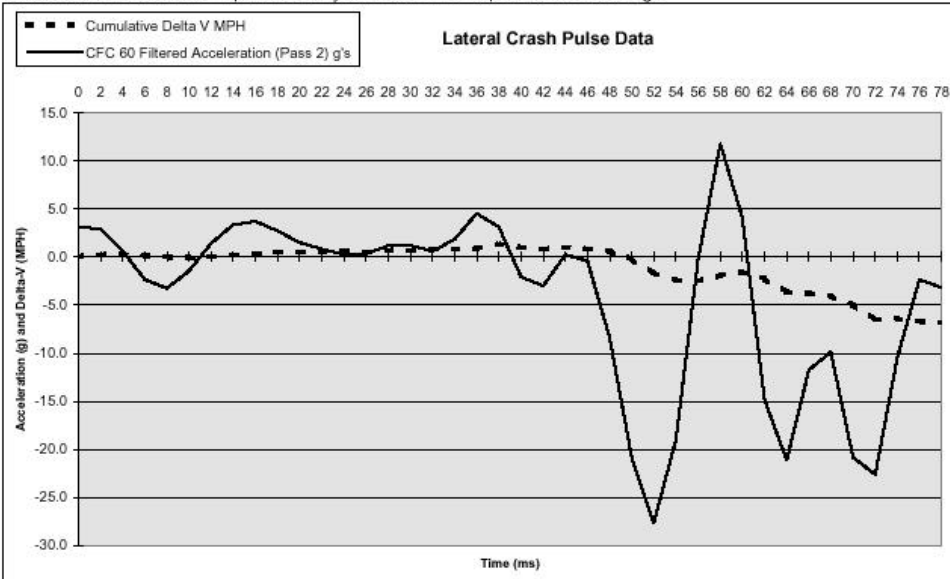
Note: Acceleration data and plots are only valid for frontal impact event recordings.



#### Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.1	0.0	0.5	0.7	1.0	-0.2	-1.5	-5.0	-6.8

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



File Name: ds01-006.hex

## 2000 Taurus/Sable EDR Report - Memory Dump

### Hexidecimal Module Memory Dump

Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
0800	10	4A	40	76	14	FB	FF	FF	FF	FF	0E	24	0F	2D	3A	57
0810	C8	FF	00	FF	52	60	52	60	60	52	E3	20	3C	78	D6	A0
0820	08	03	28	37	5F	0F	0F	0A	F5	0A	B7	84	A1	5E	C9	95
0830	03	0C	1B	1E	00	FF	3C	3C	80	06	28	64	64	00	0C	01
0840	5A	96	50	FF	FF	FF	EF	DF	D5	E7	FF	72	4E	13	25	B1
0850	EC	14	09	0F	01	FF	FF	73	7F	FF	CD	44	08	FF	FF	95
0860	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0870	05	3C	49	10	6C	00	8F	FF	59	46	31	41	00	03	FF	19
0880	02	FE	80	09	FE	80	0A	FE	80	0F	FE	80	13	FE	80	FF
0890	2B	FE	80	35	FF	80	38	FF	80	FF	FF	00	FF	FF	00	FF
08A0	04	86	08	00	00	08	20	01	00	00	FF	FF	FF	FF	FF	FF
08B0	02	FF	81	38	00	8D	01	FF	FF	FF	FF	FF	23	01	E1	EF
08C0	FF	14	01	E1	F0	43	01	E1	F0	08	50	88	71	03	FF	FE
08D0	01	0E	0C	80	02	58	16	87	1F	BE	01	0A	00	8C	01	04
08E0	00	F0	01	36	00	A0	01	54	00	3F	02	30	02	C7	02	8A
08F0	05	14	07	08	01	2C	03	CA	04	CE	06	40	73	33	00	A0
0900	3F	FF	00	03	00	4B	01	CC	00	03	0F	FF	00	14	00	78
0910	00	A0	00	6E	0A	16	FF	01	00	00	00	7F	0F	0C	0F	02
0920	03	5A	32	46	05	50	02	02	FA	1E	08	0C	0A	1C	02	23
0930	09	06	28	32	16	20	16	1F	5F	FF	FF	02	FF	FF	FF	11
0940	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0950	26	00	29	00	25	00	00	1E	00	00	01	00	20	1E	1F	1F
0960	24	26	30	25	25	26	21	00	00	00	00	29	31	2A	27	29
0970	00	00	BD	B0	A1	7E	B2	B3	AF	AF	B3	B9	B3	AC	B1	B0
0980	A3	B4	B3	BB	B0	CC	A8	5B	6C	68	87	95	6F	5F	B3	D2
0990	5A	AD	9A	AD	BD	A6	A0	A5	B8	AC	BE	AE	B9	B8	B5	9A
09A0	9D	A1	A5	98	A1	A5	9F	A3	A1	A0	92	A0	A2	66	81	D2
09B0	5E	94	97	B5	69	A0	6E	80	2B	08	A2	EB	19	34	29	9B
09C0	1D	84	AE	70	B0	DD	CE	83	86	7F	79	77	7B	82	84	86
09D0	84	80	7F	83	77	88	7C	82	80	82	93	6E	76	88	75	73
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