

On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS00016
2000 Ford Taurus
Arkansas
June, 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 crashworthiness performance of the involved vehicle(s) or their safety systems.

Technical Report Documentation Page

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16. Abstract This case was initiated because the case vehicle was equipped with an advanced air bag protection system. This crash occurred in Arkansas in June, 2000 at 1520 hours. At the point of impact the roadway is a four-leg intersection. The case vehicle is a 2000 Ford Taurus SE 4-door that was driven by a restrained 30-year-old male (178 cm/70 in., 82 kg/180 lbs). The front right seat of the case vehicle was occupied by a restrained 46-year-old female (168 cm/66 in., 91 kg/200 lbs.). The case vehicle was northbound in the far right lane approaching the intersection and intending to cross through the intersection. The other vehicle is a 1998 International 4700 4x2 80 van body truck that was driven by a restrained 24-year-old male. The other vehicle was traveling eastbound in the far right lane approaching the intersection and intending to cross through the intersection. The driver of the case vehicle stated to the police that he was unfamiliar with the area and did not see the stop sign. He "ran" the stop sign and the front of the other vehicle struck the left front (10LYEW2) side of the case vehicle. On impact, both frontal air bags in the case vehicle deployed. At impact the case vehicle sustained a total delta v of 15.3 km/in (9.5 mph), a longitudinal delta v of -5.2 km/in (-3.3 mph) and a latitudinal delta v of 14.4 km/in (9.0 mph). After impact, the case vehicle rotated clockwise and there was a second impact between the case vehicle and the other vehicle; the left rear C-pillar and backlight area of the case vehicle side-slapped the right side of the other vehicle. After second impact, the case vehicle rotated clockwise approximately 190 degrees and came to final rest heading south-west in the eastbound travel lane of the south-east corner of the intersection. The other vehicle rotated slightly counterclockwise and came to final rest heading east in the westbound travel lane of the north-east roadway, east of the intersection. The driver of the case vehicle sustained contusions to the left shoulder and left chest. The front right occupant sustained contusions to the chest and at both knees.					
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Dynamic Science, Inc.
Accident Investigation
Case Number: DS00016

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BACKGROUND:

Description: This Advanced Occupant Protection Systems case was generated by DSI through existing insurance contacts. NHTSA was notified of the case on August 28, 2000. DSI was assigned the case on August 29, 2000 and an on-site investigation was conducted. All field work was completed on August 30, 2000.

Investigation Type: On-scene

Crash Location: Arkansas

Crash Date: June, 2000

Notification Date: August 28, 2000

Field Work Completed: August 30, 2000

SUMMARY:

This crash occurred in Arkansas in June, 2000 at 1520 hours. At the point of impact the roadway is a four-leg intersection. The northbound road is a one way, two lane, undivided roadway that leads to a freeway on-ramp. The northbound travel lanes are asphalt surface that is straight with a +1.2% grade. Northbound traffic is controlled by standard stop signs. The eastbound roadway is a two way, two lane, divided roadway. The eastbound travel lanes are asphalt surfaced that are straight and level. Eastbound traffic is not controlled. The speed limit for both directions of travel is 48 km/in (30 mph).

There were no obstructions or roadway defects reported. The weather was dry and clear with an ambient temperature was 90EF (32.2EC).



Figure 1. Case vehicle's approach to area of impact (north).

The crash occurred in Arkansas in June, 2000 at 1520 hours. The case vehicle is a 2000 Ford Taurus SE 4-door that was driven by a restrained 30-year-old male (178 cm/70 in., 82 kg/180 lbs). The front right seat of the case vehicle was occupied by a restrained 46-year-old female (168 cm/66 in., 91 kg/200 lbs.). Restraint use was determined by interviewee information, information from the police report, and seat latch usage shown in the Electronic Data Recorder (EDR). There were no indications of crash related usage found during the vehicle inspection. The case vehicle was northbound in the far right lane approaching the intersection and intending to cross through the intersection. The other vehicle is a 1998 International 4700 4x2 80 van body truck that was driven by a restrained 24-year-old male. The other vehicle was traveling eastbound in the far right lane approaching the intersection and intending to cross through the intersection.



Figure 2. Other vehicle's approach to the area of impact (east).

The driver of the case vehicle stated to the police that he was unfamiliar with the area and did not see the stop sign. He "ran" the stop sign and the front of the other vehicle struck the left front (10LYEW2) side of the case vehicle. On impact, both frontal air bags in the case vehicle deployed. At impact the case vehicle sustained a total delta v of 15.3 km/in (9.5 mph), a longitudinal delta v of -5.2 km/in (-3.3 mph) and a latitudinal delta v of 14.4 km/in (9.0 mph) as computed by WinSmash¹. This is a borderline reconstruction and the results appear low. The data from the Restraint Control Module (RCM) was downloaded. The EDR report shows a longitudinal cumulative delta v of 14.3 km/h (-8.9 mph) at the 78 ms mark and a lateral cumulative delta v of 21.7 km/h (13.5 mph) at the 78 ms mark.

After impact, the case vehicle rotated clockwise and there was a second impact between the case vehicle and the other vehicle; the left rear C-pillar and backlight area of the case vehicle side-slapped the right side of the other vehicle.

¹ Calculated with WinSmash 1.2.1, Barrier algorithm using stiffness and size values in NASS Coding Manual.

After second impact, the case vehicle rotated clockwise approximately 190 degrees and came to final rest heading south-west in the eastbound travel lane of the south-east corner of the intersection. The other vehicle rotated slightly counterclockwise and came to final rest heading east in the westbound travel lane of the north-east roadway, east of the intersection.

The driver of the case vehicle sustained contusions to the left shoulder and left chest. The front right occupant sustained contusions to the chest and at both knees. EMS were notified at 1520 hours and arrived at the scene at 1545 hours. The driver and front right passenger of the case vehicle were transported via ground ambulance to a medical facility for treatment. Both occupants were treated and then released.

The driver of the other vehicle did not report any injuries to police.

The case vehicle sustained total damage and was later declared a total loss by the insurance company. The other vehicle sustained damage estimated repair costs at \$10,000.00 by the police. Both vehicles were towed from the scene.



Figure 3. Front left view of case vehicle



Figure 4. Case vehicle, left side, second impact



Figure 5. Exemplary 1 1998 International 4700 4x2 80 in steel cab

Scene Diagram

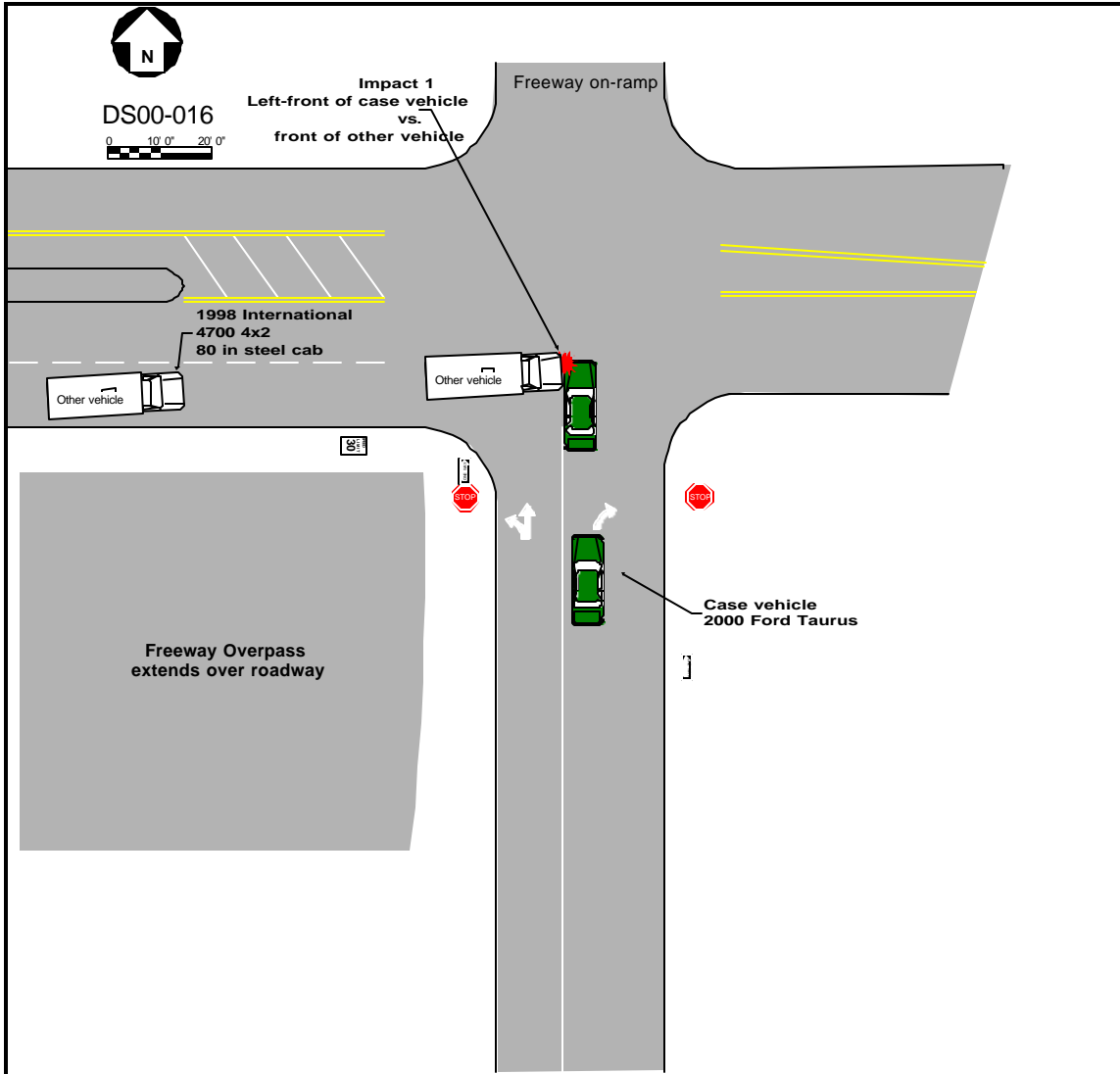


Figure 6. Scene

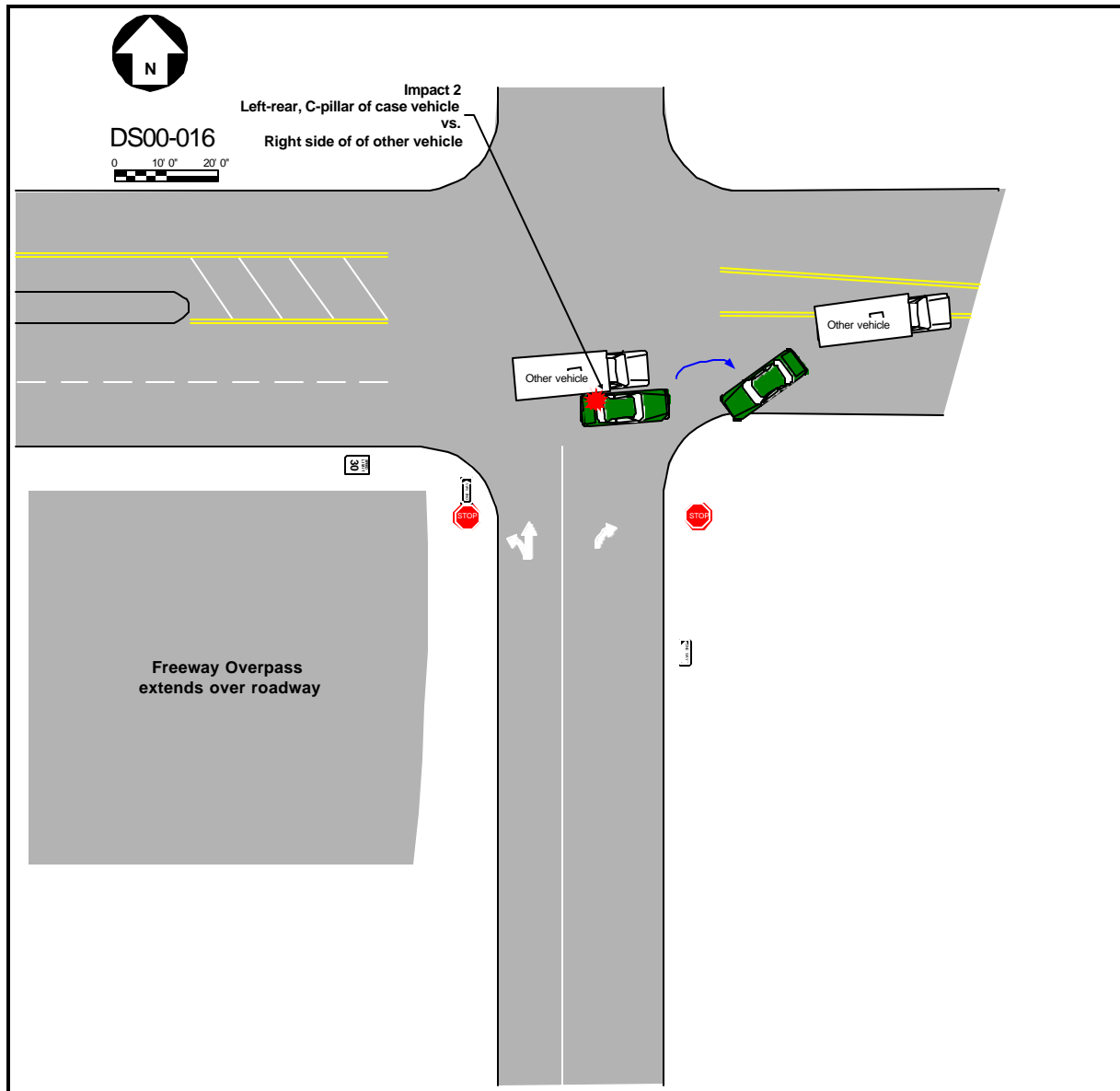


Figure 7. Scene diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2000 Ford Taurus SE 4-door	
VIN:	1FAFP53U4YAxxxxxx	
Odometer:	13,945 km (8,665 miles)	
Engine:	3.0 L	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate side damage to left front fender from the initial impact. The left axle was deformed. There was damage to the C-pillar and the left rear from the side-slap impact.	
CDC:	Impact 1: 10LYEW2 Impact 2: 09LYGW2	
Delta V (Impact 1) ² :	Total	15.3 km/h (9.5 mph)
	Longitudinal	-5.2 km/h (-3.3 mph)
	Latitudinal	14.4 km/h (9.0 mph)
	Energy	26,081 joules (19,242 ft-lbs)



Figure 8. Front, case vehicle

²Calculated using WinSmash with the barrier option

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 case vehicle sustained a total Δv of 15.3 km/in (9.5 mph), a longitudinal Δv of -5.2 km/in (-3.3 mph) and a latitudinal Δv of 14.4 km/in (9.0 mph) as computed by WinSmash. This is a borderline reconstruction and the results appear low. The EDR report shows a longitudinal cumulative Δv of 14.3 km/h (-8.9 mph) at the 78 ms mark and a lateral cumulative Δv of 21.7 km/h (13.5 mph) at the 78 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. Stage 2 was purged for disposal.
2. The driver's seat was in the forward position.
3. The left front and right front seat buckles were engaged.
4. The time from algorithm wake-up to pretensioner was 0 milliseconds. The pretensioners did not fire.
5. The time from algorithm wake-up to first stage - belted was 66 milliseconds.
6. There was a difference in 6 milliseconds between driver's time from algorithm wakeup to first stage deployment attempt and the passenger's time. This seems to be related to the sensing of the driver's seat track being in the forward position. The inference would be



Figure 9. Driver's air bag



Figure 10. Front right passenger air bag

that since the driver is presumed to be closer to the steering wheel, it would be necessary to deploy sooner.

The reason the pretensioners did not fire while the air bags did was put to Ford. Their response is as follows: “The 2000MY Taurus pretensioner threshold is an independent calculation from the airbag threshold. While the pretensioner threshold is generally similar to the belted/driver seat forward airbag threshold, and while in general the pretensioners will deploy at the same time as the airbags or prior to the airbags, it is possible for the air bags to deploy before the pretensioners or for the air bags to deploy and not the pretensioners. Ford believes that is what occurred in this case, given the 8.9 MPH delta-V would have resulted in a prediction very near the two thresholds (pretensioner deployment threshold and air bag deployment threshold). If the impact had been more severe, both air bag and pretensioner would likely have deployed. There is nothing in the file that suggests the system did not perform as designed.”

The 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. There was grease/dirt on the face and back of the air bag. It appears that this was not due to occupant contact. The module cover opened in an “H” configuration. There were no indications of any damage to the cover or air bag.

The front right passenger’s air bag was rectangular and measured 44 cm (17.3 in) by 55 cm (21.7 in). It was equipped with two vent ports and did not have any tethers. On the face and back of the passenger’s air bag there was black smudging that was due to contact with the module cover. The single flap module cover opened properly. There were no indications of damage to the front right passenger’s air bag or module cover.

As stated earlier, both front seat positions were equipped with seat belt pretensioners. The pretensioner barrels were checked and measured 11 cm (4.3 in.), indicating that they had not deployed.

There was no steering column stroke and the steering column breakaway coupling was intact.

Other vehicle

Description: 1998 International 4700 4x2 van body heavy truck, 25,500 GVW

VIN: 1HTSCABM8WHxxxxxxx

Odometer: Unknown

Engine: Navistar 446 CID diesel

Reported Defects: None noted

Cargo: Unknown

Damage Description: Estimated by police at \$10,000. Vehicle was disabled and was towed from the scene.

TDC: Unknown

Delta V: Total NA
 Longitudinal NA
 Latitudinal NA
 Energy NA

Additional vehicle specifications provided by police:

Length	701 cm (276 in.)
Width	244 cm (96 in.)
Height	373 cm (147 in.)

Occupants

<u>Case vehicle</u>	Occupant 1	Occupant 2
Age/Sex:	30/Male	46/Female
Seated Position:	Front left	Front right
Seat Type:	Fabric covered bucket-seat adusted to between middle and rear most track position	Fabric covered bucket-seat adusted to between middle and rear most track position
Height:	178 cm (70 in.)	168 cm (66 in.)
Weight:	82 kg (180 lbs)	91 kg (200 lbs)
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel, unknown clock direction	Unknown
Foot Position:	Right foot on accelerator, left on floor	Both feet on floor
Restraint Usage:	Lap and shoulder belt available and used.	Lap and shoulder belt available and used.
Air bag:	Driver's air bag available. Air bag deployed.	Front right passenger's air bag available. Air bag deployed.

Other vehicle

Age/Sex:	24/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Truck driver
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Restraint used. Type unknown

Injuries and Injury Mechanisms

Vehicle 1

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Contusion, left shoulder	790402.1,2	923.00	Door side panel
	Contusion, left chest	490402.1,2	922,1	Steering wheel, air bag
RF Occupant:	Contusion, right chest	490402.1,1	922.1	Seat belt
	Contusion, left knee	890402.1,2	924.11	Instrument panel
	Contusion, right knee	890402.1,1	924.11	Instrument panel

Occupant Kinematics

The driver of Vehicle 1 was seated in a normal, upright position. He was wearing the available lap and shoulder belt. As the case vehicle was broadsided by the other vehicle, the driver of the case vehicle responded to the 290E direction of principal force by moving to the left and forward—striking the door panel which caused the left shoulder contusion and engaging the deploying air bag with the left side of his chest which caused a minor contusion. As the case vehicle rotated clockwise and side-slapped the right side of the other vehicle with its rear left side, the driver responded to 270E direction of principal force by moving to the left. There was no evidence of loading on the steering column, there was no indication of shear capsule movement.



Figure 11. Driver position, possible knee contact

The front right occupant was seated in a normal, upright position. She was using the available lap and shoulder belt. During the first impact—broadside of the case vehicle's left front—the front right occupant responded to the 290E direction of principal force by moving laterally to the left and forward—loading her torso belt and causing the chest contusion and then striking the lower instrument panel causing the bilateral knee contusions. The front right passenger's air bag deployed and this occupant likely contacted it to some degree, though there was no evidence of any specific contact. As the case vehicle rotated clockwise and side-slapped the right side of the other vehicle with its rear left side, the front right occupant responded to 270E direction of principal force by moving to the left.

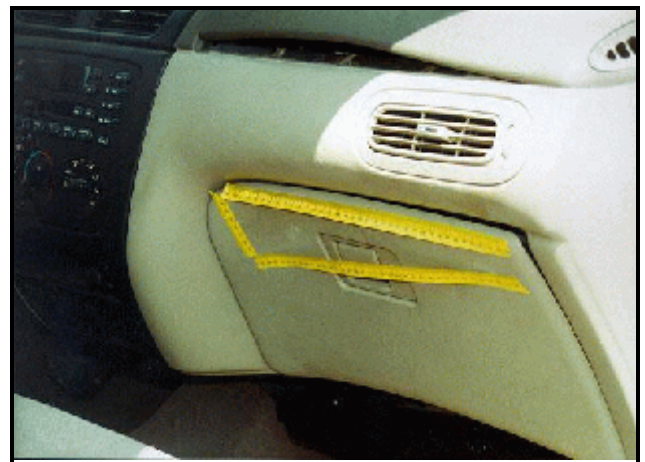


Figure 12. Front right occupant, knee contacts

Attachment 1. EDR Reports

2000 Taurus/Sable EDR Report - Summary Page

Investigation Data

File Name:	DS00-016.hex	File Save Date:	01-Sep-2000
File Read-out Date:	N/A	Report Date:	08-Dec-2000
Report Version:	1.5		

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:	0
Time From Algorithm Wakeup to First Stage - Unbelted:	60
Time From Algorithm Wakeup to First Stage - Belted:	66
Time From Algorithm Wakeup to Second Stage:	0

Restraint System Status

Driver Seat Belt Buckle:	Engaged
Passenger Seat Belt Buckle:	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:	Not Deployed	Not Deployed
Time From Algorithm Wakeup to First Stage Deployment Attempt:	60	66
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Disposal	Disposal

Notes

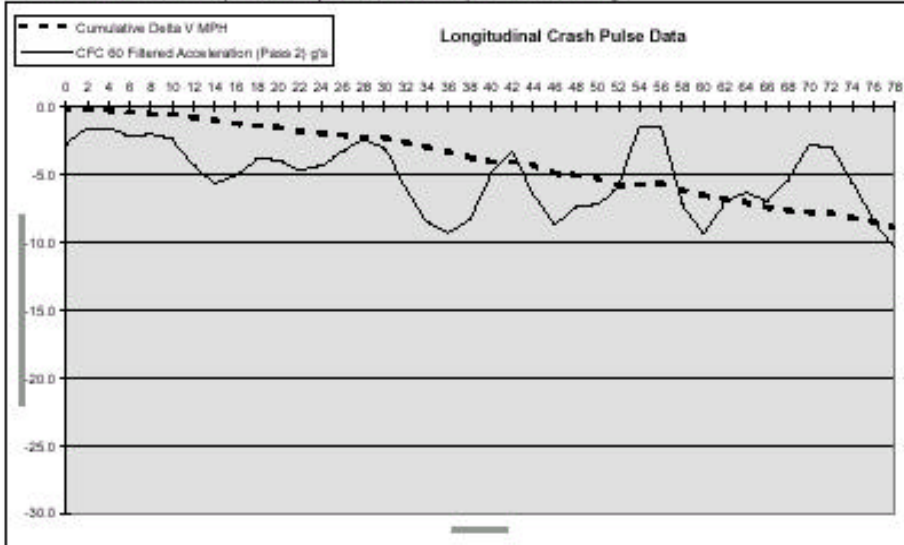
1. Read-out date is set by the PC interface tool.
2. Features and data parameters which are not available on the module are marked "N/A".
3. CFC 60 is a Butterworth 4-pole phaseless digital filter. (See SAE J211 Part 1 Appendix C dated March 1995.)
4. Total and maximum Delta-V results are not available 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	-0.5	-1.5	-2.2	-4.0	-5.2	-6.5	-7.7	-8.9

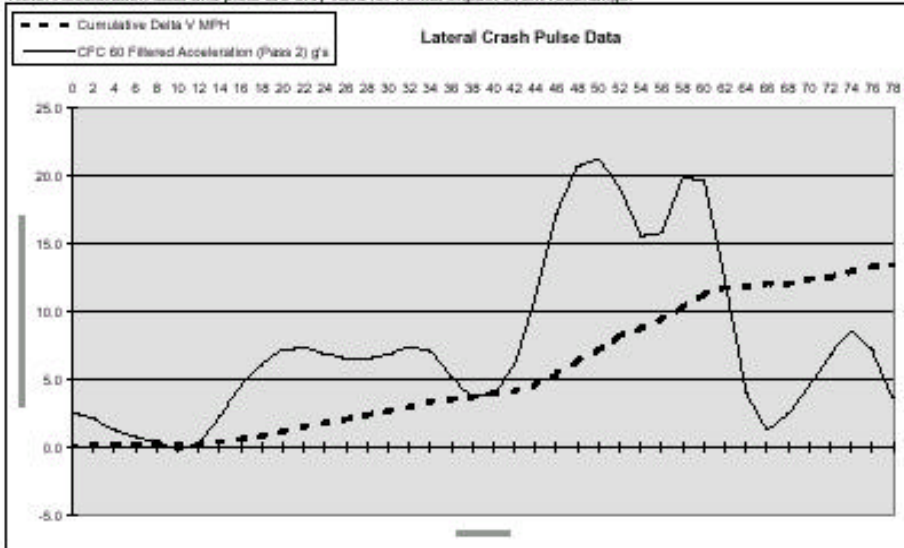
Note: Acceleration data and plots are only valid for frontal impact event recordings.



Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.1	0.3	1.4	3.7	8.0	12.2	13.3	12.4	13.5

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



File Name: DS00-016.hex