

On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS01-004
2000 Ford Taurus SE four-door
North Carolina
November, 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 <p>This case was initiated because the case vehicle was equipped with an Advanced Occupant Protection System (AOPS) and an Electronic Data Recorder (EDR). This was a three vehicle head-on type collision. The collision occurred in North Carolina in November, 2000 at 1415 hours on a two lane U.S. highway. The case vehicle is a 2000 Ford Taurus SE 4-door that was driven by a restrained 42-year-old male. The front right seat of the case vehicle was occupied by a restrained 46-year-old female. The other vehicle is a 1992 Dodge Ram pickup that was driven by a 61-year-old male. The third vehicle is a 1994 Pontiac Sunbird that was driven by a 20-year-old female. There were two additional occupants in the third vehicle; an 18-year-old male was seated in the front right and a 1-year-old female was seated in the middle rear. The case vehicle was traveling north directly behind the Pontiac. The Dodge was heading south traveling towards the case vehicle and the Pontiac. The driver of the Dodge suffered a stroke and drove into northbound-opposing traffic lanes. The front of the Dodge struck the left front of Pontiac. The driver of the case vehicle saw the crash between the Dodge and the Pontiac and stopped the case vehicle. The Dodge continued moving forward and struck the front (12FDEW2) of the case vehicle. On impact both of the air bags in the case vehicle deployed. After the collision with the Dodge the case vehicle rotated clockwise approximately 180 degrees and came to final rest heading south in the northbound travel lane. The Dodge, after colliding with the case vehicle, ran off the roadway on the east edge. It slid sideways down a steep embankment and rolled over one and a half times and came to rest on its top, trapping the driver. The engine began to leak gas and the Dodge caught on fire. The Pontiac rotated counterclockwise after colliding with the Dodge and came to final rest heading south-west straddling north and southbound travel lanes. All three vehicles were towed from the scene due to damage. EMS arrived on the scene and treated injured parties and transported them to a local hospital. The extent of any injuries is not known.</p>					
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Accident Investigation
Case Number: DS01-004

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BACKGROUND:

Description: This Advanced Occupant Protection Systems case was reported to the NHTSA by DSI on March 14, 2001 and the case was assigned to DSI on March 16, 2001. An on-site investigation was conducted and all field work was completed on March 26, 2001.

Investigation Type: On-scene
 Crash Location: North Carolina
 Crash Date: November, 2000
 Notification Date: March 16, 2001
 Field Work Completed: March 26, 2001

SUMMARY:

This was a three vehicle head-on type collision. The collision occurred in North Carolina in November, 2000 at 1415 hours on a two lane U.S. highway. The highway is a two-lane, two-way, undivided roadway. The straight northbound asphalt roadway has a negative 2.2% grade and the straight southbound asphalt roadway a positive 2.2% grade. The posted speed limit is 89 km/h (55 mph).

The case vehicle is a 2000 Ford Taurus SE 4-door that was driven by a restrained 42-year-old male. The front right seat of the case vehicle was occupied by a restrained 46-year-old female. The other vehicle is a 1992 Dodge Ram pickup that was driven by a 61-year-old male. The third vehicle is a 1994 Pontiac Sunbird that was driven by a 20-year-old female. There were two additional occupants in the third vehicle; an 18-year-old male was seated in the front right and a 1-year-old female was seated in the middle rear.



Figure 1. Direction of travel for the case vehicle-(north).

The case vehicle was traveling north directly behind the Pontiac. The Dodge was heading south traveling towards the case vehicle and the Pontiac. The driver of the Dodge suffered a stroke and drove into northbound-opposing traffic lanes. The front of the Dodge struck the left front of Pontiac. The driver of the case vehicle saw the crash between the Dodge and the Pontiac and stopped the case vehicle. The Dodge continued moving forward and struck the front (12FDEW2) of the case vehicle. On impact both of the air bags in the case vehicle deployed. The case vehicle sustained a total delta v

of 46.4 km/h (28.8 mph), a longitudinal delta v of -46.2 km/h (-28.7 mph), and a latitudinal delta v of 4.0 km/h (2.5 mph)¹. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -35.8 km/h (-23.2 mph) at the 78 ms mark. The data indicates that the driver's and front right passenger's seat belts were engaged and that both pretensioners fired. The EDR report is included as an attachment to this report. The Dodge sustained a total delta v of 43.0 km/h (26.7 mph), a longitudinal delta v of -42.8 km/h (-26.6 mph), and a latitudinal delta v of -3.7 km/h (-2.3 mph). The WinSmash results appear high for both vehicles.



Figure 2. Exterior damage to case vehicle.

After the collision with the Dodge the case vehicle rotated clockwise approximately 180 degrees and came to final rest heading south in the northbound travel lane. The Dodge, after colliding with the case vehicle, ran off the roadway on the east edge. It slid sideways down a steep embankment and rolled over one and a half times and came to rest on its top, trapping the driver. The engine began to leak gas and the Dodge caught on fire. The Pontiac rotated counterclockwise after colliding with the Dodge and came to final rest heading south-west straddling north and southbound travel lanes.



Figure 3. Rear left of other vehicle (Pontiac)

All three vehicles were towed from the scene due to damage.

EMS arrived on the scene and treated injured parties and transported them to a local hospital. The extent of any injuries is not known.

¹Calculated using the Missing Vehicle algorithm of WinSmash 1.2.1 and stiffness values for the case vehicle calculated using NCAP crash data.

Scene Diagram

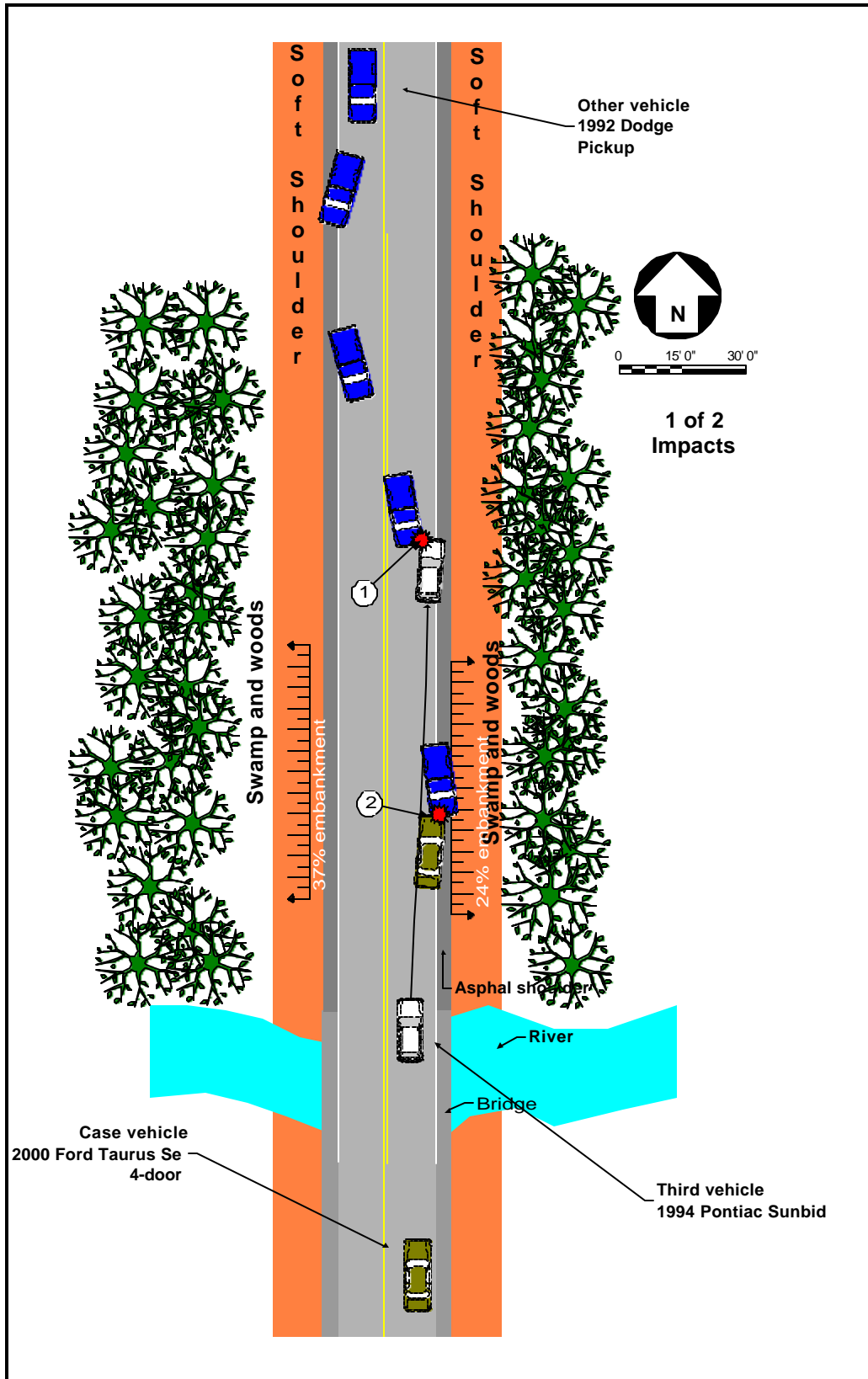


Figure 4. Scene diagram (1 of 2)

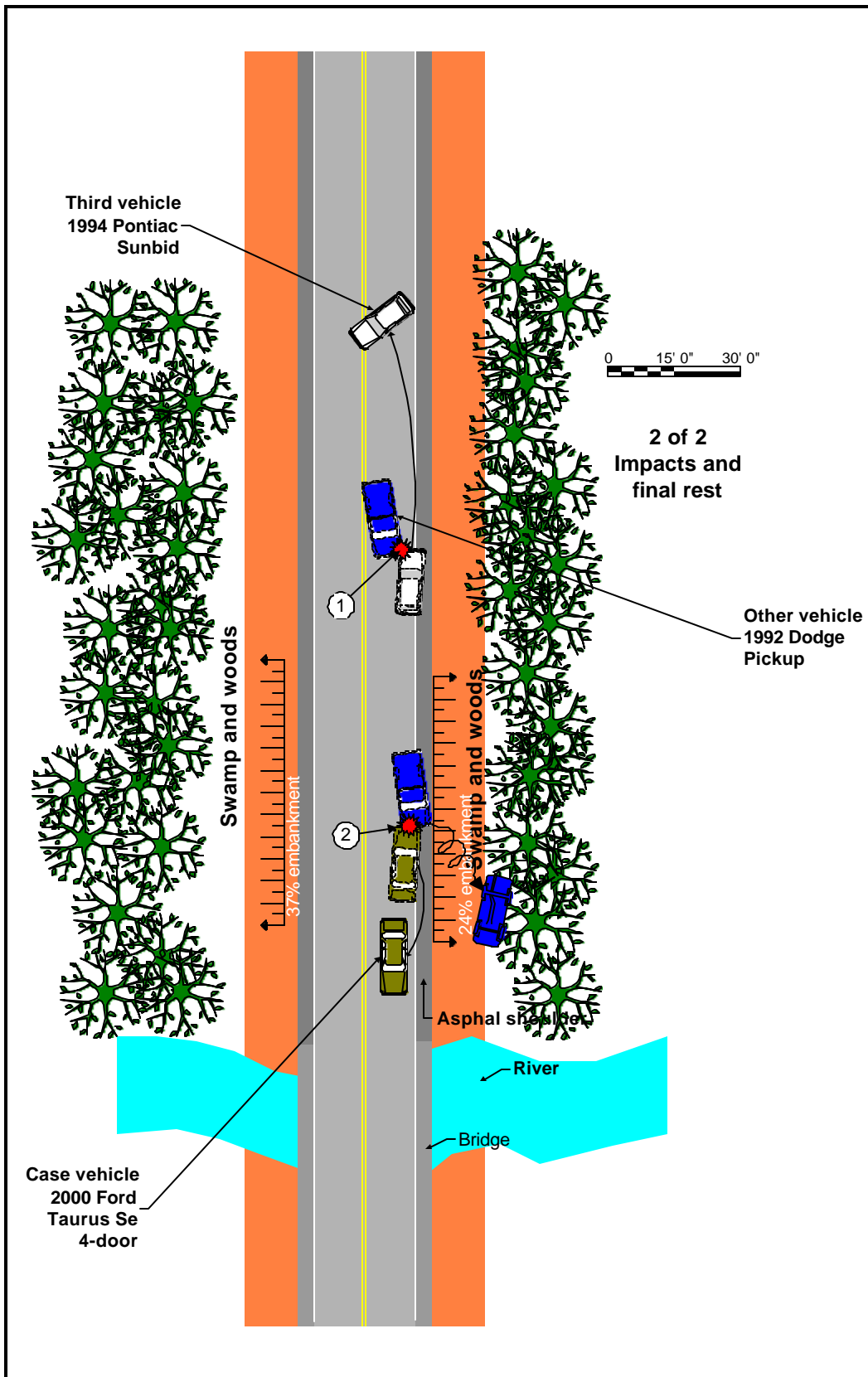


Figure 5. Scene diagram (2 of 2)

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2000 Ford Taurus SE four-door	
VIN:	1FAFP56S7YAxxxxxx	
Odometer:	22,216 km (13,805 miles)	
Engine:	3.0 L V6	
Reported Defects:	None noted	
Cargo:	None	
Damage Description:	Moderate rearward crush mostly on the right front. Towed from the scene. Insurance company declared it a total loss.	
CDC:	12FDEW2	
Delta V:	Total	46.4 km/h (28.8 mph)
	Longitudinal	-46.2 km/h (-28.7 mph)
	Latitudinal	4.0 km/h (2.5 mph)
	Energy	89,776 joules (66,226 ft-lbs)



Figure 6. Exterior damage to case vehicle.

AOPS discussion

This vehicle was equipped with advanced occupant protection system features. The system consists of a Restraint Control Module (RCM), dual stage front air bags, seat belt pretensioners, seat track sensors, and seat belt sensors. 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 delta v of 46.4 km/h (28.8 mph), a longitudinal delta v of -46.2 km/h (-28.7 mph), and a latitudinal delta v of 4.0 km/h (2.5 mph) as calculated by WinSmash. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -35.9 km/h (-22.3 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.
2. The driver's seat was not in the forward position.
3. The left front and right front seat buckles were engaged.
4. The time from algorithm wake-up to pretensioner activation was 16 milliseconds.
5. The time from algorithm wake-up to first stage deployment was 48 milliseconds.

The case vehicle was equipped with a driver's and front right passenger's air bags. The driver's steering wheel mounted 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 a black smudge on the upper right quadrant of the air bag, but these appeared to be as a result of contact with the air bag module covers and not of occupant contact. There was also a yellow smear of unknown origin on the back of the air bag. The dual module covers opened in a typical "H" configuration. There were no indications of any damage to the cover. The front right passenger's top mounted air bag was rectangular and measured 58 cm (22.8 in.) by 44 cm (17.3 in.). It was equipped with two vent ports and did not have any tethers. On the face of the air bag there was cover-related scuffing and there was a 5 cm (2 in.) cut to the upper right corner of the air bag that was caused by cracked windshield glazing. The single flap module cover did not sustain any damage.

Both front seat positions of the case vehicle were equipped with seat belt pretensioners. The pretensioner barrels were measured. The driver's pretensioner measured 4.7 cm (1.9 in.)--indicating that it had fired. The front right passenger's pretensioner measured 4.9 cm (1.9 in.)--indicating that it had also fired. There was no steering column stroke and the steering column breakaway coupling was intact.

Other vehicle

Description:	1992 Dodge Ram pickup 4 x 2	
VIN:	1B7GE16X8NSxxxxxxx	
Odometer:	Unknown	
Engine:	3.9 L 6 CYL	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	FL2: Front left, extent of deformity ² =2 FR5: Front right, extent of deformity=5 L&T5: Left side and rollover, extent of deformity=5	
	Police estimate \$5,000 in damage. Vehicle was towed from the scene.	
CDC:	Unknown	
Delta V:	Total	43.0 km/h (26.7 mph)
	Longitudinal	-42.8 km/h (-26.6 mph)
	Latitudinal	-3.7 km/h (-2.3 mph)
	Energy	180,547 joules (133,130 ft-lbs)

²For North Carolina, the severity of damage is based on a scale of "0" being no damage and "7" being the most severe damage.

Other vehicle

Description: 1994 Pontiac Sunbird four-door sedan

VIN: 1G2JB54H0R7xxxxxx

Odometer: 183,527 km (114,042 miles), per salvage yard

Engine: 2.0 L L4

Reported Defects: None reported

Cargo: Unknown

Damage Description: Left side, left doors. Towed from the scene.
Insurance company declared it a total loss.

CDC: 12LYAW2

Delta V:

Total	Unknown
Longitudinal	Unknown
Latitudinal	Unknown
Energy	Unknown



Figure 7. Left side, other vehicle (Pontiac)

Occupants

<u>Case vehicle</u>	Occupant 1	Occupant 2
Age/Sex:	42/Male	46/Female
Seated Position:	Front left	Front right
Seat Type:	Fabric covered bucket seat. Seat adjusted to between middle and rear most track position (35 cm rear of A pillar)	Fabric covered bucket seat. Seat adjusted to rear most track position (38 cm rear of A pillar)
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:		
Body Posture:	Normal, upright	Normal, upright.
Hand Position:		
Foot Position:	Vehicle stopped. Right foot presumed to be on brake. Left on floor.	Unknown
Restraint Usage:	Lap and shoulder belt available, used	Lap and shoulder belt available, used
Air bag:	Air bag available, deployed	Airbag available, deployed

Other vehicle (Dodge)

Age/Sex:	61/Male
Seated Position:	Front left
Seat Type:	Unknown
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	Driver had a stroke prior to crash.
Alcohol/Drug Involvement:	None
Driving Experience:	Unknown
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used, per police.

Other vehicle (Pontiac)

Age/Sex:	20/Female	18/Male	1/Female
Seated Position:	Front left	Front right	Middle rear
Seat Type:	Unknown	Unknown	Unknown
Height:	Unknown	Unknown	Unknown
Weight:	Unknown	Unknown	Unknown
Occupation:	Unknown	Unknown	Unknown
Pre-existing Medical Condition:	None noted	None noted	None noted
Alcohol/Drug Involvement:	None	None	None
Driving Experience:	Unknown	NA	NA
Body Posture:	Unknown	Unknown	Unknown
Hand Position:	Unknown	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unknown
Restraint Usage:	Automatic torso belt/manual lap available, lap and shoulder used per police	Automatic torso belt/manual lap available, lap and shoulder used per police	Unknown child safety seat in use, per police

Injuries and Injury MechanismsCase vehicle

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Injured, unknown severity			
RF Occupant:	Injured, unknown severity			

Other vehicle (Dodge)

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Injured, unknown severity			

Other vehicle (Pontiac)

	<u>INJURY</u>	<u>OIC CODE</u>	<u>ICD-9</u>	<u>SOURCE</u>
Driver:	Injured, unknown severity			
Front right occupant	Not injured			
Rear middle occupant	Injured, unknown severity			

Occupant Kinematics

The 42-year-old male driver of the case vehicle was seated in a normal, upright fashion in a fabric covered bucket seat. The seat was adjusted to between middle and rear most track position. He was wearing the available lap and shoulder belt. Prior to the crash this vehicle had stopped. The driver's right foot is presumed to be on brake and the left foot on floor. At impact, the driver seat belt pretensioner fired—tightening the seat belt. The driver pitched forward and loaded the seat belt. His left knee contacted and deformed the left lower instrument panel. His face and torso likely engaged the deployed air bag. His right hand may have struck and dislodged the center mirror. The mirror had been broken and there was blood evidence on the right side of the driver's seat cushion. The driver sustained a "B" type injury (evident) according to the police report. He was transported by ground ambulance to a local hospital. The extent of his injuries is not known.



Figure 8. Driver's seated position



Figure 9. Left knee contact.

The 46-year-old female front right occupant of the case vehicle was seated in a normal, upright fashion in a fabric covered bucket seat. The seat was adjusted to the rear most track position. She was wearing the available lap and shoulder belt. Prior to the crash this vehicle had stopped. At impact, the front right passenger seat belt pretensioner fired—tightening the seat belt. This occupant pitched forward and loaded the seat belt. The seat belt "roped" in the latch and became lodged in the latch. This would have prevented the belt from threading through the latch properly. It is not clear if this occurred as a result of the pretensioning or during the driver loading. This occupant's face and torso likely engaged the deployed air bag to some degree. This occupant sustained a B type injury (evident) according to the police report. She was transported by ground ambulance to a local hospital. The extent of her injuries is not known.

There was a star-shaped fracture in the upper right corner of the case vehicle's windshield. There were no indications of hair or tissue transfers found in the fracture. There was, however, a tear pattern found in the passenger air bag that does appear to be related to this fracture.



Figure 10. Front right occupant seated position (note the seat belt latch)



Figure 11. Front right seat belt latch

Attachment 1. EDR report

2000 Taurus/Sable EDR Report - Summary Page

Investigation Data

File Name:	DS01-004.hex	File Save Date:	26-Mar-2001
File Read-out Date:	N/A	Report Date:	27-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:	16
Time From Algorithm Wakeup to First Stage - Unbelted:	24
Time From Algorithm Wakeup to First Stage - Belted:	48
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:	No
Passenger Seat Weight Switch Position:	N/A

Deployment Initiation Attempt Times

	Driver	Passenger
Time From Algorithm Wakeup to Pretensioner Deployment Attempt:	16	16
Time From Algorithm Wakeup to First Stage Deployment Attempt:	48	48
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Disposal	Disposal

Notes

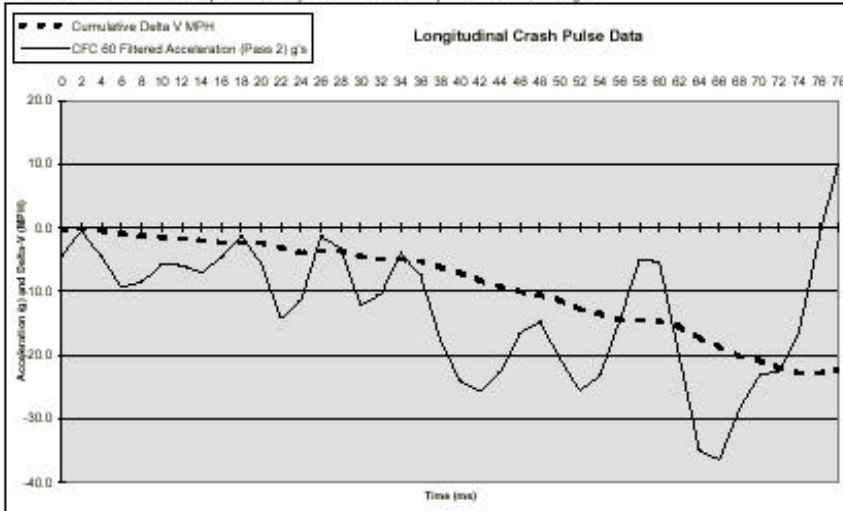
1. Read-out date is set by the PC interface tool.
2. Features and data parameters which are not available on the module are marked "N/A".
3. CFC 60 is a Butterworth 4-pole phaseless digital filter. (See SAE J211 Part 1 Appendix C dated March 1995.)
4. Total and maximum Delta-V results are not available 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)	-0.4	-1.0	-2.3	-4.0	-7.3	-11.4	-14.7	-20.8	-22.3

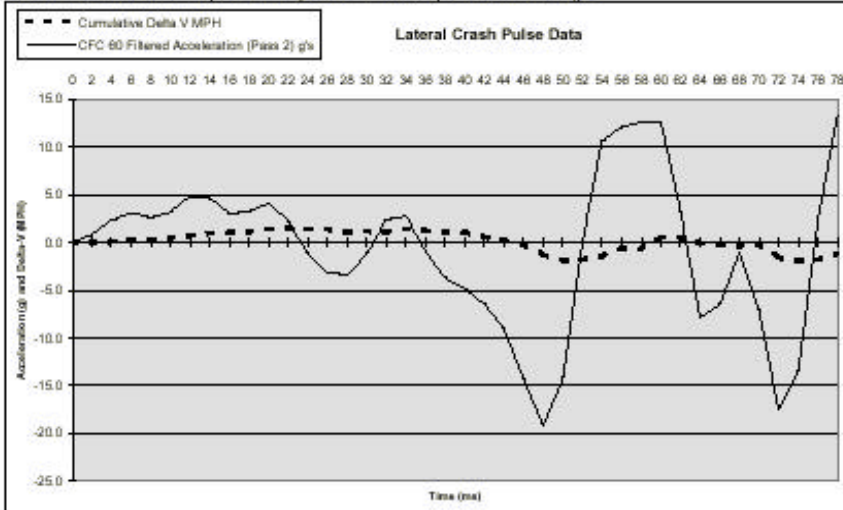
Note: Acceleration data and plots are only valid for frontal impact event recordings.



Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.0	0.1	1.4	1.2	1.1	-1.8	0.5	-0.1	-1.3

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



File Name: DS01-004.hex