

On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS00-019
2000 Ford Taurus
Illinois
July, 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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| 15. Supplemental Notes | | | | | |
| 16. Abstract <p>This case was initiated because the case vehicle was equipped with an Advanced Occupant Protection System. This is a two vehicle, head-on type collision. The case vehicle is a 2000 Ford Taurus SE station wagon that was driven by a restrained 29-year-old female. The front right seat was occupied by a restrained 50-year-old male. The other vehicle is a 1991 Chevrolet Lumina 4-door that was driven by a restrained 32-year-old female.</p> <p>The case vehicle was traveling southbound, and the Chevrolet was traveling northbound and negotiating a right hand curve on the roadway. The driver of the case vehicle said she saw the Chevrolet traveling in her lane. The driver of the case vehicle took evasive action by braking. The Chevrolet however continued coming at the case vehicle. The driver of the Chevrolet indicated that she must have fallen asleep and all she remembers was striking the case vehicle. The Chevrolet crossed into the southbound lane and the front of the case vehicle (12FDEW1) collided head-on with the Chevrolet. On impact, both front air bags in the case vehicle deployed. At impact the case vehicle sustained a total delta v of 37.0 km/h (23.0 mph), a longitudinal delta v of -36.4 km/h (-22.6 mph) and a latitudinal delta v of -6.4 km/h (-4.0 mph). The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -38.1 km/h (-23.7 mph) at the 78 ms mark. The case vehicle sustained major damage and was towed from the scene due to damage. The case vehicle was later declared a total loss. The Chevrolet sustained damage sufficient to require towing from the scene. The driver of the case vehicle sustained contusions to both hips, the left side of her chest, and both knees. She also sustained a cervical strain. She was transported to hospital for treatment and released. The front right passenger sustained seat belt contusions to his right chest, abdomen and right shoulder. He was not transported. The driver of the Chevrolet also sustained "A" type injuries. The police report indicates that the injured received EMS attention and were transported to a hospital.</p> | | | | | |
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Dynamic Science, Inc.
Accident Investigation
Case Number: DS00-019

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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 September 25, 2000. DSI was assigned the case on September 26, 2000 and an on-site investigation was conducted. All field work was completed on September 29, 2000.

Investigation Type: On-scene

Crash Location: Illinois

Crash Date: July, 2000

Notification Date: September 25, 2000

Field Work Completed: September 29, 2000

SUMMARY:

The collision occurred in Illinois in July, 2000 at 2356 hours. It was dark at the time of the crash, but the roadway was lighted. At the point of impact the roadway is a two way, two lane, undivided asphalt roadway. There is a single lane for northbound traffic with a positive 1.9% grade. There is a single lane for southbound traffic with a negative 1.8% grade. The roadway is bordered on both sides by a dirt/gravel shoulder. No traffic controls are present.

This is a two vehicle, head-on type collision. The case vehicle is a 2000 Ford Taurus SE station wagon that was driven by a restrained 29-year-old female (59 in/149.9 cm-115 lb/52 kg). The front right seat was occupied by a restrained 50-year-old male (68 in/172.7 cm-170 lb/77 kg). The other vehicle is a 1991 Chevrolet Lumina 4-door that was driven by a restrained 32-year-old female.

The case vehicle was traveling southbound, and the Chevrolet was traveling northbound and negotiating a right hand curve on the roadway. The driver of the case vehicle said she saw the Chevrolet traveling in her lane. The driver of the case vehicle took evasive action by braking. The Chevrolet however continued

coming at the case vehicle. The driver of the Chevrolet indicated that she must have fallen asleep and all she remembers was striking the case vehicle. The Chevrolet crossed into the southbound lane and the front of the case vehicle (12FDEW1) collided head-on with the Chevrolet.



Figure 1. Approach to impact area for Chevrolet–north.

On impact, both front air bags in the case vehicle deployed. At impact the case vehicle sustained a total delta v of 37.0 km/h (23.0 mph), a longitudinal delta v of -36.4 km/h (-22.6 mph) and a latitudinal delta v of -6.4 km/h (-4.0 mph) as computed by WinSmash¹. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -38.1 km/h (-23.7 mph) at the 78 ms mark. The EDR report is included as an attachment to this report.



Figure 2. Frontal damage to case vehicle.

After impact, the case vehicle was pushed backwards, rotated counterclockwise and came to final rest heading north-east straddling both traffic lanes. The Chevrolet rotated slightly counterclockwise and continued moving forward. The Chevrolet then ran off the roadway and came to final rest heading north-east, off the roadway.

The case vehicle sustained major damage and was towed from the scene due to damage. The case vehicle was later declared a total loss. The Chevrolet sustained damage sufficient to require towing from the scene.

The driver of the case vehicle sustained contusions to both hips, the left side of her chest, and both knees. She also sustained a cervical strain. She was transported to hospital for treatment and released. The front right passenger sustained seat belt contusions to his right chest, abdomen and right shoulder. He was not transported.



Figure 3. Case vehicle driver's air bag.

The driver of the Chevrolet also sustained "A" type injuries. The police report indicates that the injured received EMS attention and were transported to a hospital.

¹ Calculated with Winsmash 1.2.1, Missing Vehicle algorithm using stiffness values calculated from NCAP testing.

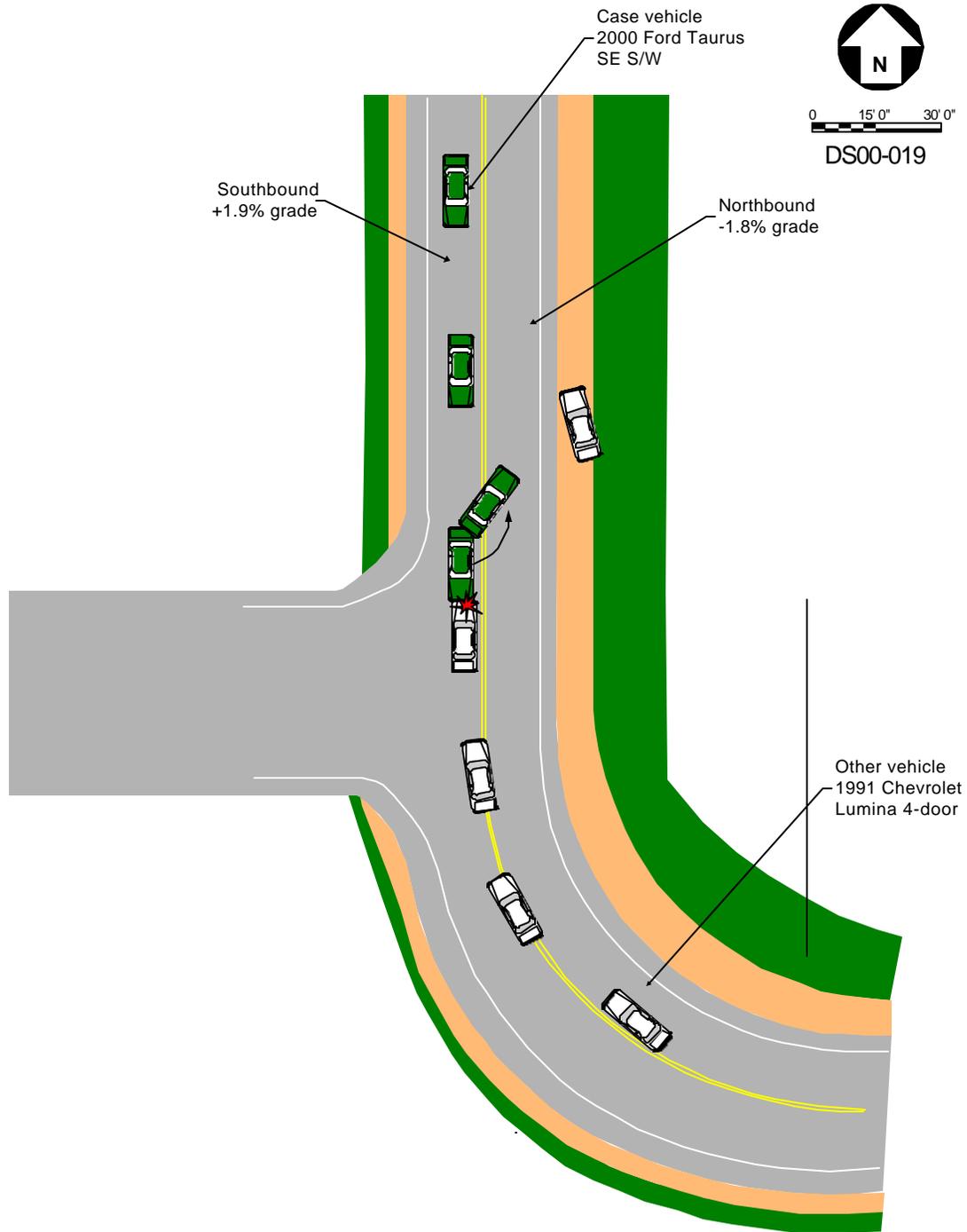


Figure 4. Case vehicle front right passenger's air bag.



Figure 5. Case vehicle—damage to knee bolster cover and adjusted foot controls.

Scene Diagram



DETAILED INFORMATION

Vehicles

Case vehicle

| | | |
|---------------------|---|----------------------------------|
| Description: | 2000 Ford Taurus station wagon ² | |
| VIN: | 1FAFP58SX46xxxxxx | |
| Odometer: | 17,837 km (11,084 miles) | |
| Engine: | 3.0 L V6 | |
| Reported Defects: | None | |
| Cargo: | None | |
| Damage Description: | Moderate frontal crush. Towed from the scene. | |
| CDC: | 12FDEW2 | |
| Delta V: | Total | 37.0 km/h (23.0 mph) |
| | Longitudinal | -36.4 km/h (-22.6 mph) |
| | Latitudinal | -6.4 km/h (-4.0 mph) |
| | Energy | 76,388 joules (56,351 ft-lbs) |



Figure 8. Front view, case vehicle



Figure 7. Angle view, case vehicle

²Company/fleet 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: 80 milliseconds of crash pulse, deployment strategy of the dual-stage air bag system, seat belt latch use, pretensioner operation, and driver seat track location.

At impact the case vehicle sustained a total delta v of 37.0 km/h (23.0 mph), a longitudinal delta v of -36.4 km/h (-22.6 mph) and a latitudinal delta v of -6.4 km/h (-4.0 mph) as computed by WinSmash³. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -38.1 km/h (-23.7 mph) at the 78 ms mark. The EDR report is included as an attachment to this report.

Both front seat positions of the case vehicle were equipped with seat belt pretensioners. The pretensioner barrels were checked and measured 5 cm (2.0 in.) for both barrels, indicating that they had deployed.

The case vehicle was also equipped with adjusted foot controls. The brake pedal had been displaced laterally to the left 2.5 cm (1.0 in), and this was probably due to heavy braking. The front barrel was checked and measured 5 cm (2.04 in).

The case vehicle driver's air bag was circular and measured 42 cm (16.5 in.) in diameter. It was equipped with two tethers and two vent holes. On the bottom of the rear portion of the air bag there was black transfer that appeared not to be a driver contact. The dual module covers opened in an "H" configuration. There were no indications of any damage to driver's air bag or the covers. The case vehicle front right passenger's air bag was rectangular and measured 43 cm (16.9 in) by 59 cm (23.2 in). It was equipped with two vent ports and did not have any tethers. On the face of the air bag there were black smudges that were caused by the module cover. The single flap module cover opened properly and was not damaged.

³ Calculated with Winsmash 1.2.1, Missing Vehicle algorithm using stiffness values calculated from NCAP testing.

Other vehicle

| | | |
|---------------------|---|-----------------------------------|
| Description: | 1991 Chevrolet Lumina | |
| VIN: | 2G1WL54T7Mxxxxxx | |
| Odometer: | Unknown | |
| Engine: | 3.1 L V6 | |
| Reported Defects: | None | |
| Cargo: | Unknown | |
| Damage Description: | Moderate frontal crush. Towed from the scene. | |
| CDC: | Unknown | |
| Delta V: | Total | 43.3 km/h (26.9 mph) |
| | Longitudinal | -42.7 km/h (-26.5 mph) |
| | Latitudinal | -7.5 km/h (-4.7 mph) |
| | Energy | 133,902 joules (98,677 ft-lbs) |

Occupants

| <u>2000 Ford Taurus</u> | Occupant 1 | Occupant 2 |
|---------------------------------|---|--|
| Age/Sex: | 29/Female | 50/Male |
| Seated Position: | Front left | Front right |
| Seat Type: | Bucket, track position not known | Bucket, adjusted to the rear-most track position |
| Height: | 150 cm (59 in.) | 172 cm (68 in.) |
| Weight: | 52 kg (115 lbs) | 77 kg (170 lbs) |
| Occupation: | Sales | Unknown |
| Pre-existing Medical Condition: | None noted | None noted |
| Alcohol/Drug Involvement: | None | None |
| Driving Experience: | > 10 years | NA |
| Body Posture: | Normal, upright | Normal, upright |
| Hand Position: | 10/2 o'clock positions - braked | Unknown |
| Foot Position: | Right foot on brake, left on floorboard | Both feet on floorboard |
| Restraint Usage: | Lap and shoulder belt used properly | Lap and shoulder belt used properly |
| Air bag: | Deployed at impact | Deployed at impact |

1991 Chevrolet Lumina

| | |
|---------------------------------|--|
| Age/Sex: | 32/Female |
| Seated Position: | Front left |
| Seat Type: | Unknown |
| Height: | Unknown |
| Weight: | Unknown |
| Occupation: | Unknown |
| Pre-existing Medical Condition: | None noted |
| Alcohol/Drug Involvement: | None |
| Driving Experience: | Presumed to be >10 years |
| Body Posture: | Unknown—driver was likely asleep |
| Hand Position: | Unknown |
| Foot Position: | Unknown |
| Restraint Usage: | Unknown - vehicle was equipped with automatic belts, police indicate that the lap and shoulder belts were being used |

Injuries and Injury Mechanisms

2000 Ford Taurus (case vehicle)

| | <u>INJURY</u> | <u>OIC CODE</u> | <u>ICD-9</u> | <u>SOURCE</u> |
|--------------|---------------------------|-----------------|--------------|------------------------------|
| Driver: | Contusion, left hip | 890402.1,2 | 924.01 | Seat belt |
| | Contusion, right hip | 890402.1,1 | 924.01 | Seat belt |
| | Contusion, left chest | 490402.1,2 | 922.1 | Seat belt |
| | Contusion, left knee | 890402.1,2 | 924.11 | Lower instrument panel |
| | Contusion, right knee | 890402.1,1 | 924.11 | Lower instrument panel |
| | Cervical strain | 640278.1,6 | 847.0 | Impact forces |
| RF Occupant: | Contusion, right chest | 490402.1,1 | 922.1 | Seat belt |
| | Contusion, abdomen | 590402.1,4 | 922.2 | Seat belt |
| | Contusion, right shoulder | 790402.1,1 | 923.0 | Seat belt |

1991 Chevrolet Lumina (other vehicle)

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

Occupant Kinematics

The driver of the case vehicle was seated in a normal, upright position and wearing the available lap and shoulder belt. The seat track position is not known. She was wearing a sweatshirt and jeans. Prior to the crash, she was steering the case vehicle and braking in an effort to avoid the collision. As the case vehicle crashed head-on with the Chevrolet, the driver of the case vehicle responded to the 10E direction of principal force by moving essentially straight forward. Both of the driver's knees struck the lower instrument panel and cracked and deformed the rigid plastic knee bolster covering and the knee bolster. She also interacted with the driver's air bag and steering column in some fashion. The right shear module measured 2.5 cm (1 in) of column stroke. The driver loaded the lap and shoulder belt as she went forward—causing the contusions to her chest and hips. The brake pedal was deformed by the driver's right foot during braking and during the impact itself. There were no injuries reported as a result of this contact. The rear view mirror was knocked off during the collision, possibly by the driver's right hand as it was flung by the driver's air bag but there was no resultant injury. .



Figure 9. Driver's seat position—knee contact to lower instrument panel

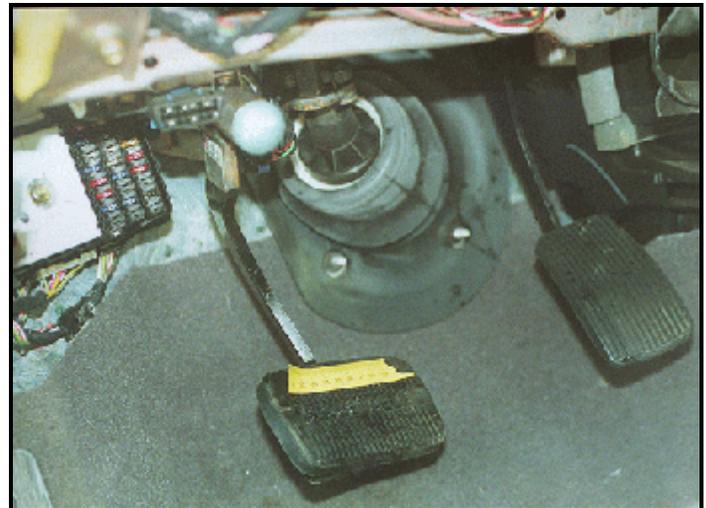


Figure 10. Deformed brake pedal

The front right occupant of the case vehicle was seated in a normal, upright position and wearing the available lap and shoulder belt. The seat track was adjusted to the rear-most track position. He responded to the head-on crash with the Chevrolet by moving straight forward. This occupant loaded the lap and shoulder belt as he went forward—causing the contusions to his chest, shoulder, and abdomen. As the front right passenger's air bag deployed he likely contacted it to some degree, though there was no evidence of any specific contact.

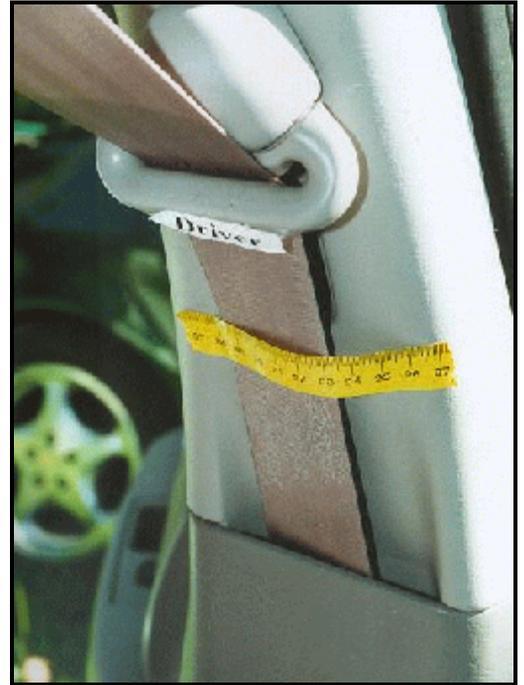


Figure 11. Belt loading marks—driver's seat belt



Figure 12. Belt loading marks—front right passenger

Attachment 1 EDR report.

2000 Taurus/Sable EDR Report - Summary Page

Investigation Data

| | | | |
|---------------------|--------------|-----------------|-------------|
| File Name: | DS00-019.hex | File Save Date: | 03-Oct-2000 |
| File Read-out Date: | N/A | Report Date: | 20-Oct-2000 |
| Report Version: | 1.4 | | |

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: | 9 |
| Time From Algorithm Wakeup to First Stage - Unbelted: | 9 |
| Time From Algorithm Wakeup to First Stage - Belted: | 20 |
| 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: | 9 | 9 |
| Time From Algorithm Wakeup to First Stage Deployment Attempt: | 20 | 20 |
| Time From Algorithm Wakeup to Second Stage Deployment Attempt: | Disposal | Disposal |

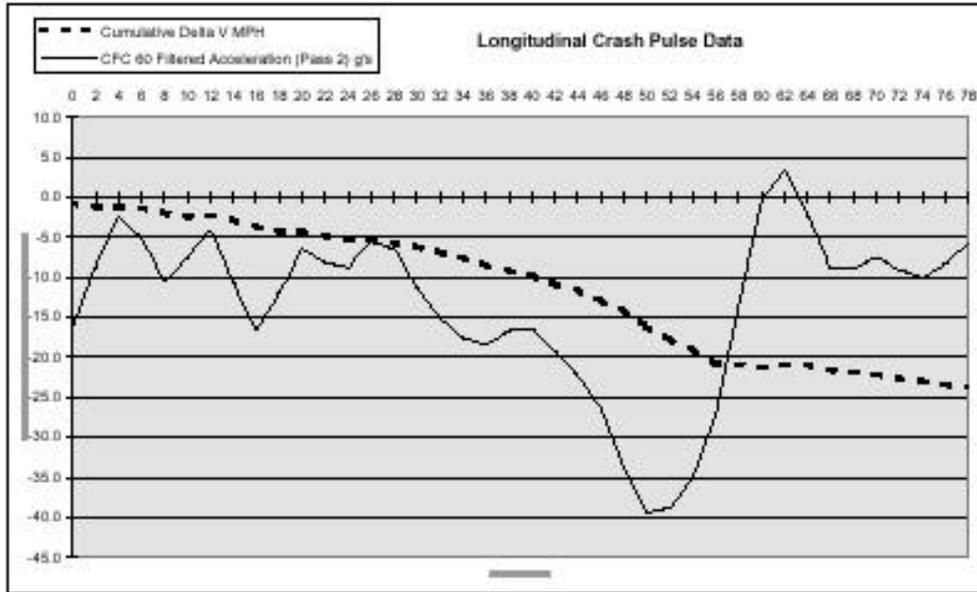
Notes

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.

2000 Taurus/Sable EDR Report - Charts

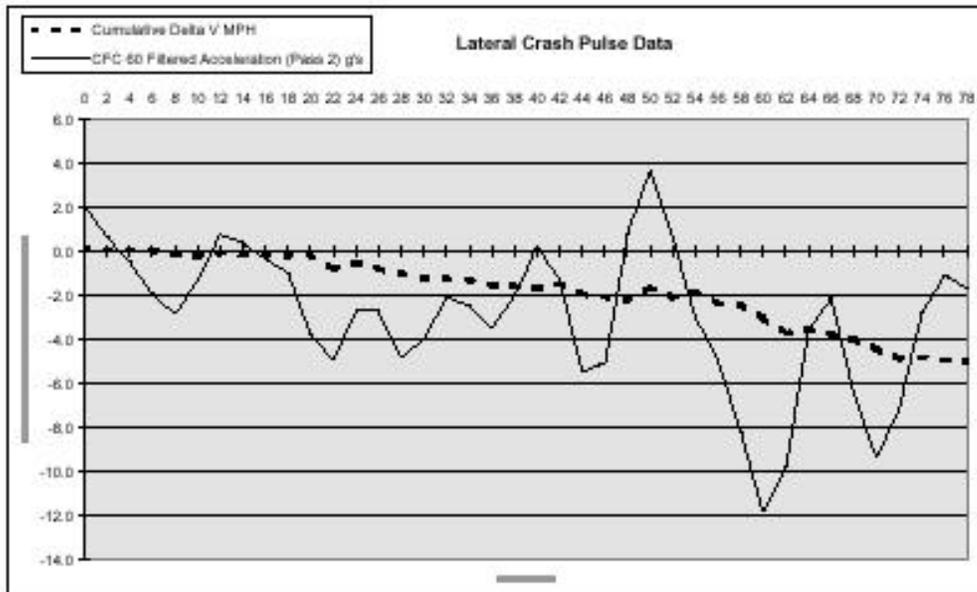
Longitudinal Cumulative Delta-V

| Time (ms) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 78 |
|---------------|------|------|------|------|------|-------|-------|-------|-------|
| Delta-V (MPH) | -0.9 | -2.5 | -4.3 | -6.2 | -9.9 | -14.2 | -21.3 | -22.1 | -22.7 |



Lateral Cumulative Delta-V

| Time (ms) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 78 |
|---------------|-----|------|------|------|------|------|------|------|------|
| Delta-V (MPH) | 0.1 | -0.2 | -0.3 | -0.2 | -1.7 | -1.6 | -3.0 | -4.4 | -5.0 |



File Name: DS00-019.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 | 0F | 4A | 40 | 76 | 14 | FB | FF | FF | FF | FF | 0E | 24 | 0F | 2D | 3A | 4C |
| 0810 | C8 | FF | 00 | FF | 52 | 60 | 52 | 60 | 60 | 52 | B3 | 20 | 3C | 78 | D6 | A0 |
| 0820 | 08 | 03 | 28 | 37 | 5F | 0F | 0F | 0A | F5 | 0A | B7 | 84 | A1 | 5E | D5 | AA |
| 0830 | 03 | 0C | 1B | 1E | 00 | FF | 3C | 3C | 80 | 06 | 28 | 54 | 64 | 00 | 0C | 01 |
| 0840 | 5A | 96 | 50 | FF | FF | FF | BF | DF | D5 | E7 | FF | 72 | 4E | 13 | 25 | B1 |
| 0850 | BC | 14 | 09 | 0F | 01 | FF | FF | 88 | 7F | FF | CD | 44 | 08 | FF | FF | 95 |
| 0860 | FF |
| 0870 | 05 | 39 | 79 | 30 | B8 | 00 | 8F | FF | 59 | 46 | 31 | 41 | 00 | 02 | FF | 16 |
| 0880 | 02 | FD | 80 | 17 | FD | 80 | 06 | FF | 7E | 12 | FD | 80 | 30 | FD | 80 | FF |
| 0890 | 35 | FF | 80 | 38 | FF | 80 | FF | FF | 00 | FF | FF | 00 | FF | FF | 00 | FF |
| 08A0 | 44 | 00 | 84 | 00 | 00 | 00 | 21 | 01 | 00 | 00 | FF | FF | FF | FF | FF | FF |
| 08B0 | 02 | FF | 81 | 38 | 00 | 8D | 01 | FF | FF | FF | FF | FF | 24 | 01 | D0 | B3 |
| 08C0 | FF | 11 | 01 | D0 | B3 | 32 | 01 | D0 | B3 | 51 | 01 | 66 | 14 | 88 | FF | FE |
| 08D0 | 01 | 0E | 0C | 80 | 02 | 58 | 16 | 87 | 1F | BE | 01 | 0A | 00 | 8C | 01 | 04 |
| 08E0 | 00 | FO | 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 | C0 | 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 |
| 0950 | 09 | 00 | 14 | 00 | 09 | 00 | 1B | 02 | 00 | 00 | 0D | 06 | 08 | 11 | 11 | 26 |
| 0960 | 04 | 06 | 09 | 10 | 09 | 11 | 05 | 12 | 00 | 00 | 08 | 14 | 16 | 0E | 0E | 0E |
| 0970 | 00 | 00 | 80 | D0 | A2 | 7F | B2 | B3 | A8 | 78 | 5C | 58 | D1 | 61 | 58 | 76 |
| 0980 | B1 | 8C | 98 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 |
| 0990 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | 7E |
| 09A0 | 8E | A1 | 9F | 82 | 8D | AC | 86 | 78 | 87 | A5 | 88 | 8A | A2 | 91 | 8B | 82 |
| 09B0 | 86 | 74 | 84 | 87 | 72 | 7D | 67 | 6B | 45 | 58 | 6A | 52 | 9F | 91 | B2 | A1 |
| 09C0 | 83 | 97 | 97 | 89 | 93 | 8D | 98 | 85 | 7E | 7F | 7D | 78 | 79 | 87 | 7D | 7C |
| 09D0 | 7E | 82 | 5F | 8F | 70 | 77 | 75 | 7E | 7B | 74 | 7F | 79 | 89 | 69 | 7A | 77 |
| 09E0 | 9B | 69 | 8C | 65 | 7D | 63 | 60 | 88 | 73 | 75 | 6C | 6B | 82 | 79 | 7B | 00 |
| 09F0 | 00 | 00 | 00 | 00 | 00 | 00 | 00 | FF | FF | 6C | 00 | FF | FF | FF | FF | 04 |

File name: DS00-019.hex