On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS01-005
2000 Ford Taurus SE 4-door
Texas
January, 2001

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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 Occupant Protection System. The collision occurred in Texas in January, 2001 at 1734 hours. This was a three vehicle, broadside type collision. The crash occurred on a seven-lane, two-way, divided roadway. The northbound roadway is comprised of three travel lanes and a left turn lane. The southbound roadway is comprised of three travel lanes and a left turn lane. The weather was cloudy and the concrete road surface was wet and slick from rain earlier in the day. The roadway is in both directions straight and level, and the posted speed limit was 72 km/h (45 mph).

The case vehicle is a 2000 Ford Taurus SE 4-door that was driven by a restrained 49-year-old male. The other vehicle is a 1998 Nissan Sentra that was driven by a 23-year-old female. The third vehicle is a 1997 Buick Riviera that was driven by a 58-year-old male. The case vehicle was traveling north in the second lane from the left. The Nissan was traveling north in the left lane, next to and ahead of the case vehicle. The Buick was traveling southbound and attempting a left turn into a private parking lot. The Buick attempted the left turn directly in front of the Nissan and the front of the Nissan struck the right side of the Buick. On impact both of the air bags in the Buick deployed. The police report indicates that the air bags in the Nissan deployed. The collision between the Buick and the Nissan caused the Nissan to rotate clockwise and directly in the path of the case vehicle. The front of the case vehicle (12FDEW1) struck the right side of the Nissan and on impact the air bags in the case vehicle deployed.

The driver of the case vehicle sustained a cervical strain, a left shoulder sprain, and a tongue laceration (driver bit his tongue).

| 17. Key Words | 18. Distribution Statement |
|---|---|
| Air bag, deployment, injury, advanced, AOPS, SDM, RCM, Vetronix | |

| 19. Security Classif. (of this report) | 20. Security Classif. (of this page) | 21. No of pages | 22. Price |
|---|---|---|---|
| | | | |

**Dynamic Science, Inc.**
**Accident Investigation**
**Case Number: DS01-005**

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**BACKGROUND:**

Description: This Advanced Occupant Protection Systems case was reported to the NHTSA by DSI on March 16, 2001 and the case was assigned on March 19, 2001 and an on-site investigation was conducted. All field work was completed on March 22, 2001.

Investigation Type: On-scene

Crash Location: Texas
Crash Date: January, 2001
Notification Date: March 19, 2001
Field Work Completed: March 22, 2001

**SUMMARY:**

The collision occurred in Texas in January, 2001 at 1734 hours. This was a three vehicle, broadside type collision. The crash occurred on a seven-lane, two-way, divided roadway. The northbound roadway is comprised of three travel lanes and a left turn lane. The southbound roadway is comprised of three travel lanes and a left turn lane. The weather was cloudy and the concrete road surface was wet and slick from rain earlier in the day. The roadway is straight and level, and the posted speed limit was 72 km/h (45 mph).

The case vehicle is a 2000 Ford Taurus SE 4-door that was driven by a restrained 49-year-old male. The other vehicle is a 1998 Nissan Sentra that was driven by a 23-year-old female. The third vehicle is a 1997 Buick Riviera that was driven by a 58-year-old male.

**Figure 1**. Path of the case vehicle (north)

**Figure 2**. Direction of travel of third vehicle–Buick (south-east).

The case vehicle was traveling north in the second lane from the left. The Nissan was traveling north in the left lane, next to and ahead of the case vehicle. The Buick was traveling southbound and attempting a left turn into a private parking lot. The Buick attempted the left turn directly in front of the Nissan and the front of the Nissan struck the right side of the Buick. On impact both of the air bags in the Buick deployed. The police report indicates that the air bags in the Nissan deployed.

**Figure 3**. Exterior damage to case vehicle.

The Sensing and Diagnostic Module (SDM) data was downloaded from the Buick using the Vetronix Crash Data Retrieval system. The data indicates a recorded maximum velocity change of -14.8 km/h (-9.21 mph) at the 120 ms mark. The data indicates that the driver was unbuckled. The SDM report is included as an attachment to this report. The Buick sustained a total delta v of 14.9 km/h (9.2 mph)[1].

**Figure 4**. Exterior damage, other vehicle (Nissan Sentra)

The collision between the Buick and the Nissan caused the Nissan to rotate clockwise and directly in the path of the case vehicle. The front of the case vehicle (12FDEW1) struck the right side of the Nissan and on impact the air bags in the case vehicle deployed. The case vehicle sustained a total delta v of 24.3 km/h (15.1 mph), a longitudinal delta v of -23.9 km/h (-14.8 mph), and a latitudinal delta v of 4.2 km/h (2.6 mph)[2]. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -22.2 km/h (-13.8 mph) at the 78 ms mark. The data indicates that the driver's seat belt was engaged and that the pretensioner on the driver's side fired. The Nissan sustained a total delta v of 34.2 km/h (21.2 mph), a longitudinal delta v of 22.0 km/h (13.6 mph), and a latitudinal delta v of -26.2 km/h (-16.3 mph). The WinSmash results fit the collision model for both vehicles and appear reasonable for the case vehicle but borderline for the Nissan.

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[1]Calculated using WinSmash with estimated CDC only for the Sentra

[2]Calculated using the Missing Vehicle algorithm of Winsmash 1.2.1 and stiffness values for the case vehicle calculated using NCAP crash data.

All the vehicles were towed from the scene due to damage. The engine in the case vehicle started but there was no radiator fluid. The engine in the Buick also started but the rear right axle was severely damaged.

**Figure 5**. Exterior damage to other vehicle (Buick Riviera).

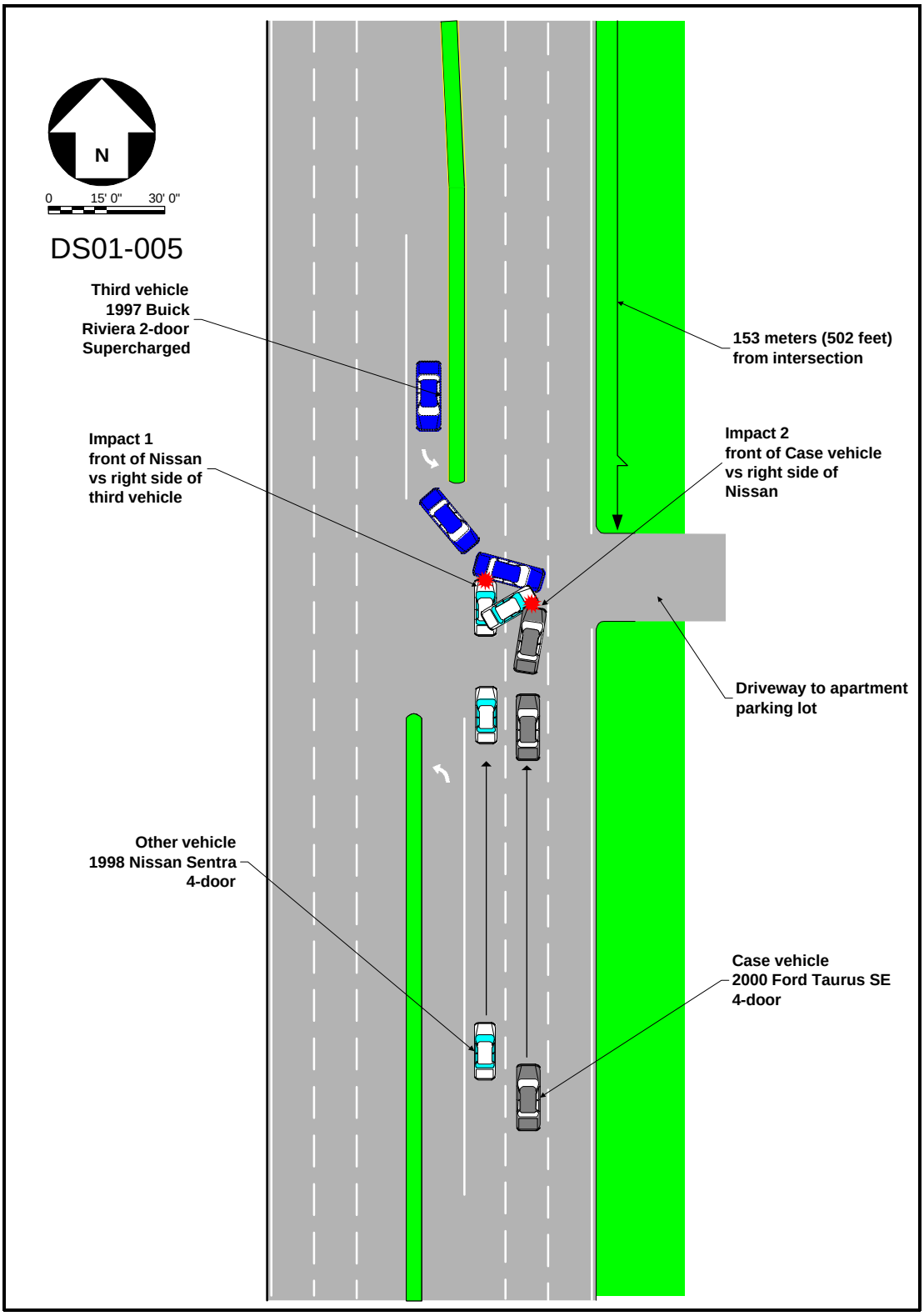
The police were notified of the collision at 1736 hours and arrived at the scene at 1743 hours. The local fire department was notified at 1734 hours and arrived at the scene at 1748 hours.

The driver of the case vehicle sustained a cervical strain, a left shoulder sprain, and a tongue laceration (driver bit his tongue). The police reported that he sustain "B" type injuries consisting of pain throughout his body. He was transported to a hospital by the local fire department personnel where he was treated and released after three hours.

The driver of the Nissan sustained "B" type injuries consisting of a cut on the left side of her neck. She declined medical treatment at the scene and indicated that she would seek medical attention at a later time.

The driver of the Buick did not report any injuries to the police at the scene.

## Scene Diagram



## DETAILED INFORMATION

### Vehicles

Case vehicle

| | | |
|---|---|---|
| Description: | 2000 Ford Taurus SE | |
| VIN: | 1FAFP53U9YGxxxxxx | |
| Odometer: | 28,203 km (17,525 miles) | |
| Engine: | 3.0 L V6 | |
| Reported Defects: | None | |
| Cargo: | None | |
| Damage Description: | Moderate frontal damage. Bumper, grille, radiator. Vehicle towed from scene. | |
| CDC: | 12FDEW1 | |
| Delta V: | Total | 24.3 km/h (15.1 mph) |
| | Longitudinal | -23.9 km/h (-14.8 mph) |
| | Latitudinal | 4.2 km/h (2.6 mph) |
| | Energy | 14,591 joules (10,767 ft-lbs) |

**Figure 7**. Front right, case vehicle, Ford Taurus

**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.

At impact the case vehicle sustained a total delta v of 24.3 km/h (15.1 mph), a longitudinal delta v of -23.9 km/h (-14.8 mph), and a latitudinal delta v of 4.2 km/h (2.6 mph) as computed by WinSmash. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -22.2 km/h (-13.8 mph) at the 78 ms mark. There is a reasonable match between the WinSmash results and the EDR data. 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 seat buckle was engaged and the right front seat buckle was not.
4. The time from algorithm wake-up to pretensioner was 16 milliseconds.
5. The time from algorithm wake-up to first stage - belted was 26 milliseconds.

The case vehicle driver's air bag was circular and measured 43 cm (16.9 in) in diameter. It was equipped with two tethers and two vent holes. On the top left of the air bag face 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 44 cm (17.3 in) high by 57 cm (22.4 in) wide. 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.

Both front seat positions of the case vehicle were equipped with seat belt pretensioners. The front right pretensioner barrel was checked and measured 3.5 cm (1.4 in.)–indicating that it had fired. The front left pretensioner barrel was checked and measured 10.8 cm (4.3 in)–indicating that it had not fired.

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

Other vehicle (Nissan Sentra)

| | | |
|---|---|---|
| Description: | 1998 Nissan Sentra | |
| VIN: | 3N1AB41D8WLxxxxxx | |
| Odometer: | Unknown | |
| Engine: | 1.6 L 4 cylinder | |
| Reported Defects: | None | |
| Cargo: | Unknown | |
| Damage Description: | Moderate frontal damage from initial impact. Bumper, grille, hood. Moderate front right fender damage from second impact. | |
| CDC<br>(Impact 1 v. Buick)<br>(Impact 2 v. case vehicle): | <br>12FDEW1 (estimated from photo)<br>04RFEW2 | |
| Delta V (Impact 2 v. case vehicle): | Total | 34.2 km/h (21.2 mph) |
| | Longitudinal | 22.0 km/h (13.6 mph) |
| | Latitudinal | -26.2 km/h (-16.3 mph) |
| | Energy | 84,019 joules<br>(61,970 ft-lbs) |

**Figure 8**. Front right, Nissan Sentra

Other vehicle (Buick Riviera)

| | | |
|---|---|---|
| Description: | 1997 Buick Riviera | |
| VIN: | G4GD2211V4xxxxxx | |
| Odometer: | 84,900 km (52,756 miles) | |
| Engine: | 3.8 L V6 | |
| Reported Defects: | None | |
| Cargo: | None | |
| Damage Description: | Moderate lateral crush to right rear. | |
| CDC: | 02RZEW4 | |
| Delta V: | Total | 14.9 km/h (9.2 mph) |
| | Longitudinal | -9.5 km/h (-5.9 mph) |
| | Latitudinal | -11.4 km/h (-7.1 mph) |
| | Energy | 25,606 joules (18,898 ft-lbs) |

**Figure 9**. Right side, Buick Riviera

**Occupants**

| Case vehicle (Ford Taurus) | Occupant 1 |
|---|---|
| Age/Sex: | 49/Male |
| Seated Position: | Front left |
| Seat Type: | Fabric covered bucket. Seat track was adjusted to rear-most position. |
| Height: | 173 cm (68 in.) |
| Weight: | 84 kg (185 lbs) |
| Occupation: | Nurse. |
| Pre-existing Medical Condition: | None |
| Alcohol/Drug Involvement: | None |
| Driving Experience: | Presumed to be greater than 20 years. |
| Body Posture: | Normal, upright. |
| Hand Position: | Unknown |
| Foot Position: | |
| Restraint Usage: | Lap and shoulder belt available, used |
| Air bag: | Steering wheel mounted air bag, deployed |

Other vehicle (Nissan Sentra)

| | |
|---|---|
| Age/Sex: | 23/Female |
| Seated Position: | Front left |
| Seat Type: | Unknown |
| Height: | Unknown |
| Weight: | Unknown |
| Occupation: | Charity case manager |
| Pre-existing Medical Condition: | Unknown |
| 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 |
| Air bag: | Air bag deployed–per police |

Other vehicle (Buick Riviera)

| | |
|---|---|
| Age/Sex: | 58/Male |
| Seated Position: | Front left |
| Seat Type: | Bucket |
| Height: | Unknown |
| Weight: | Unknown |
| Occupation: | Unknown |
| Pre-existing Medical Condition: | Unknown |
| Alcohol/Drug Involvement: | None |
| Driving Experience: | Presumed to be greater than 20 year |
| Body Posture: | Unknown |
| Hand Position: | Unknown |
| Foot Position: | Unknown |
| Restraint Usage: | Lap and shoulder belt used–per police |
| Air bag: | Air bag deployed–per police |

**Injuries and Injury Mechanisms**

Case vehicle (Ford Taurus)

| | INJURY | OIC CODE | ICD-9 | SOURCE |
|---|---|---|---|---|
| Driver: | Cervical strain | 640278.1,6 | 847.0 | Air bag |
| | Left shoulder sprain | 740402.1,2 | 840.9 | Seat belt |
| : | Tongue laceration (driver bit his tongue) | 243402.1,8 | 873.8 | Air bag |

Other vehicle (Buick Riviera)

| | INJURY | OIC CODE | ICD-9 | SOURCE |
|---|---|---|---|---|
| Driver: | No reported injuries | | | |

Other vehicle (Nissan Sentra)

| | INJURY | OIC CODE | ICD-9 | SOURCE |
|---|---|---|---|---|
| Driver: | No reported injuries | | | |

**Occupant Kinematics**

The 49-year-old male driver (173 cm/68 in, 84 kg/185 lbs) of the case vehicle was seated in a normal, upright fashion. He was wearing the available lap and shoulder belt. The upper anchorage adjustment was in the mid position. The fabric-covered bucket seat was adjusted to the rear most track position. The seat back angle was adjusted at 73 degrees from horizontal. He was wearing glasses. His right foot was on the accelerator. At impact, the driver responded to the 350 degrees direction of force by moving straight forward. The lap and shoulder belts restricted this forward motion–causing the left shoulder sprain. His face came into contact with the deployed air bag–causing the cervical strain as his head loaded the air bag and also causing the driver to bite his tongue. The drive reported that he felt a stinging sensation as the air bag contact his face. His glasses were knocked off his face but were not damaged. He also reported seeing a lot of smoke in the vehicle and hearing a loud bang from the air bag. He was transported to a hospital by the local fire department personnel where he was treated and released after three hours.

**Figure 10**. Driver's seated position

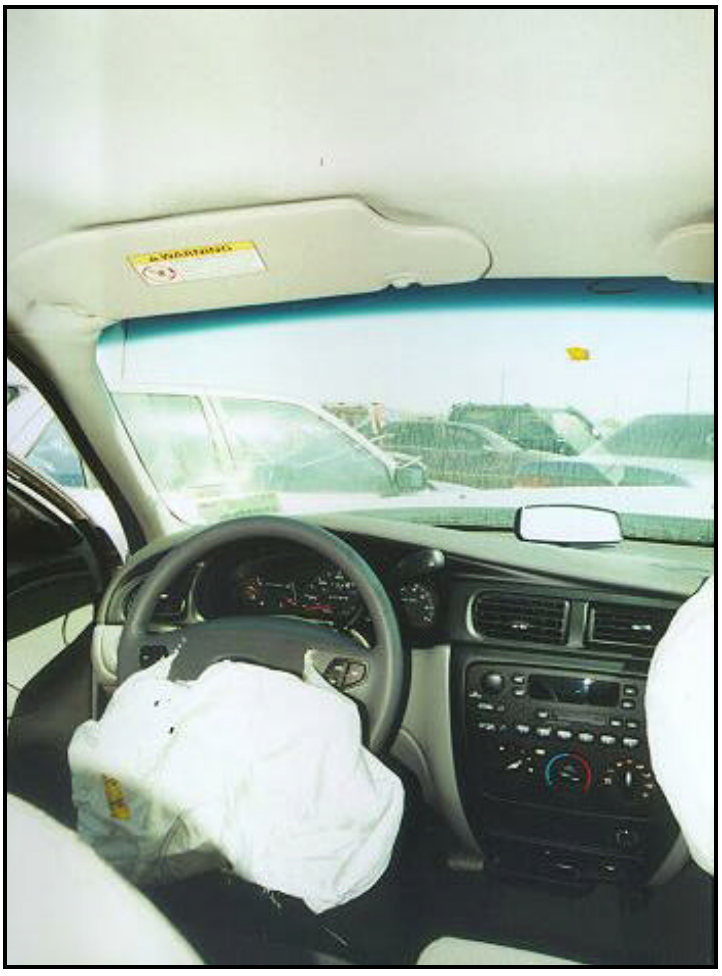


**Figure 11**. Front left interior

**Attachment 1. EDR report** (Ford Taurus)

## 2000 Taurus/Sable EDR Report - Summary Page

### Investigation Data

| | | | |
|---|---|---|---|
| File Name: | DS01-005.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: | 16 |
| Time From Algorithm Wakeup to First Stage - Unbelted: | 25 |
| Time From Algorithm Wakeup to First Stage - Belted: | 26 |
| 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: | No |
| Passenger Seat Weight Switch Position: | N/A |

| Deployment Initiation Attempt Times | Driver | Passenger |
|---|---|---|
| Time From Algorithm Wakeup to Pretensioner Deployment Attempt: | 16 | Unbelted |
| Time From Algorithm Wakeup to First Stage Deployment Attempt: | 26 | 26 |
| 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.

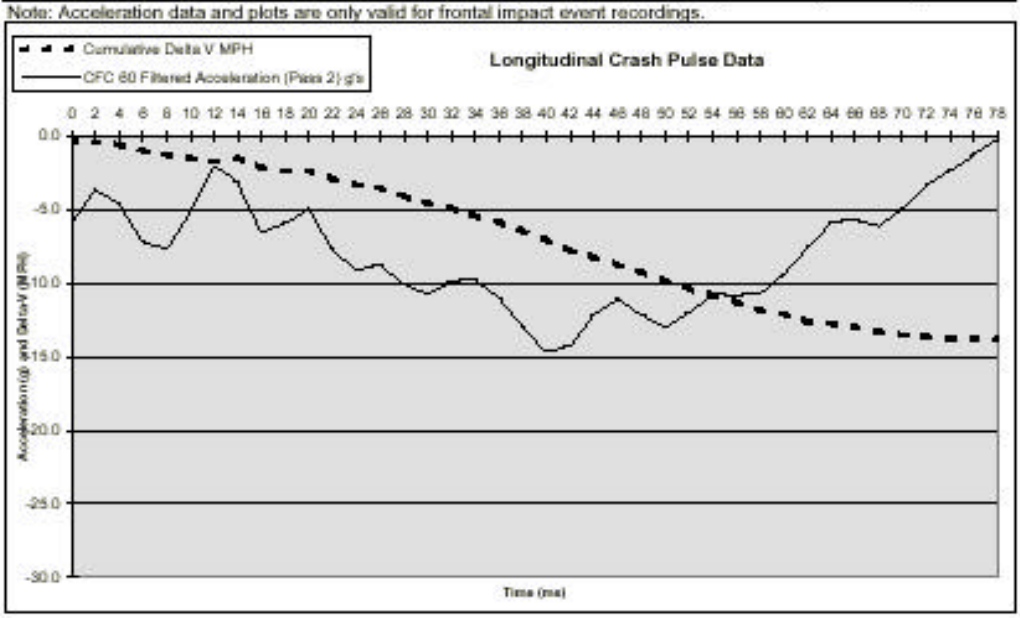
EDR Summary Report Page 1

# 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 | -1.6 | -2.3 | -4.4 | -7.1 | -9.9 | -12.1 | -13.6 | -13.8 |

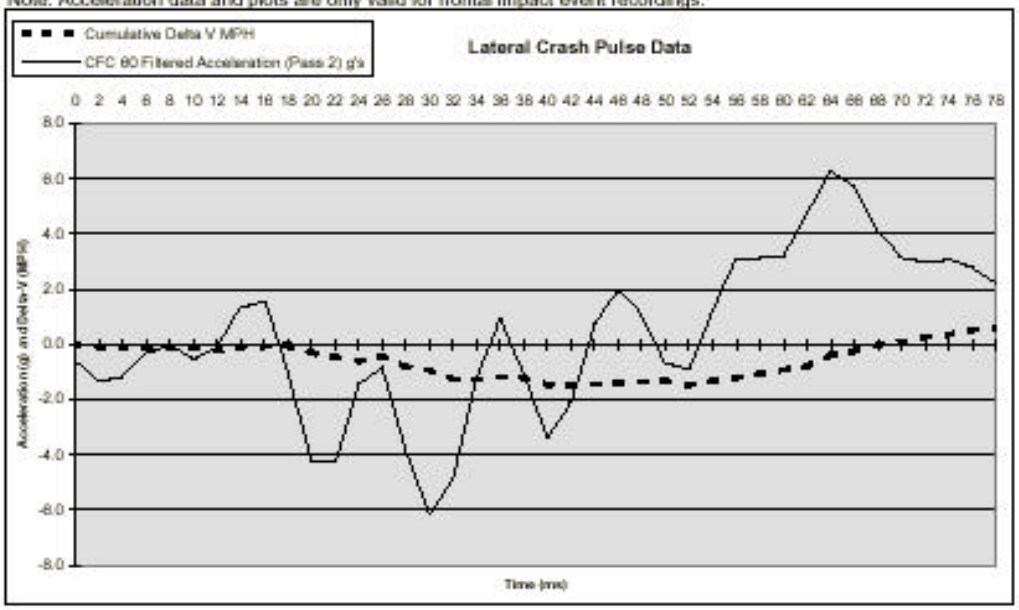
Note: Acceleration data and plots are only valid for frontal impact event recordings.




**Lateral Cumulative Delta-V**

| Time (ms) | 0 | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 78 |
|---|---|---|---|---|---|---|---|---|---|
| Delta-V (MPH) | 0.0 | -0.2 | -0.3 | -0.9 | -1.6 | -1.3 | -0.9 | 0.1 | 0.4 |

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




**File Name:** DS01-006.hex

## Attachment 2. SDM Report (Buick)

| 1G4GD2211V[redacted] System Status At Deployment | |
|---|---|
| SIR Warning Lamp Status | OFF |
| Driver's Belt Switch Circuit Status | UNBUCKLED |
| Passenger Front Air Bag Suppression Switch Circuit Status | ON |
| Ignition Cycles At Deployment | 8966 |
| Ignition Cycles At Investigation | 8974 |
| Time From Algorithm Enable To Deployment Command (msec) | 15 |
| Time From Near Deployment To Deployment (msec) | N/A |

| Time (milliseconds) | 10 | 20 | 30 | 40 | 50 | 60 | 70 | 80 | 90 | 100 | 110 | 120 | 130 | 140 | 150 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Recorded Velocity Change (MPH) | -0.88 | -2.85 | -3.73 | -5.05 | -6.36 | -7.68 | -8.34 | -8.78 | -8.78 | -9.00 | -9.00 | -9.21 | -9.00 | -8.78 | -8.78 |
| | | | | | | | | | | | | | | | |
| Time (milliseconds) | 160 | 170 | 180 | 190 | 200 | 210 | 220 | 230 | 240 | 250 | 260 | 270 | 280 | 290 | 300 |
| Recorded Velocity Change (MPH) | -8.56 | -8.34 | -8.34 | -8.34 | -8.12 | -8.12 | -7.90 | -7.90 | -7.68 | -7.68 | -7.46 | -7.46 | -7.24 | -7.24 | -7.02 |