

**TRANSPORTATION SCIENCES  
CRASH DATA RESEARCH CENTER**

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**ADVANCED OCCUPANT PROTECTION SYSTEM STUDY  
2000 FORD TAURUS SE INVESTIGATION**

**VERIDIAN CASE NO. CA00-044**

**LOCATION - MICHIGAN**

**CRASH DATE - SEPTEMBER 2000**

**Contract No. DTNH22-94-07058**

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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 of the involved vehicle(s) or their safety systems.

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<p>17. <i>Abstract</i></p> <p>This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) in the 2000 Ford Taurus SE. The AOPS consisted of the integrated use of 3-point lap and shoulder belts, seat belt buckle pre-tensioners, seat position sensing and dual-stage frontal air bags. The driver and front right passenger air bags were designed to deploy at different thresholds based on crash severity, restraint use, and seat position. The vehicle was not equipped with side impact air bags. The subject 2000 Ford Taurus SE was involved in an intersection crash with a 1989 Chevrolet Cavalier. The frontal air bags in the Ford Taurus SE deployed as a result of the impact. There were three occupants in the Ford Taurus SE. The 22 year old unrestrained male driver and 20 year old male unrestrained front right passenger were not injured. A 17 year old unrestrained male was the right rear occupant. He sustained a police-reported non-incapacitating injury and was transported to a local hospital.</p> <p>This crash was identified through the weekly sampling of the Michigan police jurisdictions conducted by the General Estimates System (GES). The Michigan GES site informed the NASS Zone Center 1 of this crash, which in-turn notified the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA). NHTSA assigned an on-site investigation of the crash to the Special Crash Investigations Team at Veridian Engineering as part of the Advanced Occupant Protection System Study. Specifically, the SCI team was instructed to download the crash data stored in the Restraint Control Module, as a supplement to the crash investigation.</p>			
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**ADVANCED OCCUPANT PROTECTION SYSTEM STUDY  
2000 FORD TAURUS SE INVESTIGATION  
VERIDIAN CASE NO: CA00-044  
LOCATION: MICHIGAN  
CRASH DATE: SEPTEMBER, 2000**

***BACKGROUND***

This on-site investigation focused on the performance of the Advanced Occupant Protection System (AOPS) in the 2000 Ford Taurus SE. The AOPS consisted of the integrated use of 3-point lap and shoulder belts, seat belt buckle pre-tensioners, seat position sensing and dual-stage frontal air bags. The driver and front right passenger air bags were designed to deploy at different thresholds based on crash severity, restraint use, and seat position. The Ford Taurus SE was not equipped with side impact air bags. The subject 2000 Ford Taurus SE was involved in an intersection crash with a 1989 Chevrolet Cavalier. The frontal air bags in the Ford Taurus SE deployed as a result of the impact. There were three occupants in the Ford Taurus SE. The 22 year old unrestrained male driver was not injured. The 20 year old male unrestrained front right passenger and the 17 year old unrestrained male right rear passenger sustained a police reported non-incapacitating injury.

This crash was identified through the weekly sampling of the Michigan police jurisdictions conducted by the General Estimates System (GES). The Michigan GES site informed the NASS Zone Center 1 of this crash, which in-turn notified the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA). NHTSA assigned an on-site investigation of the crash to the Special Crash Investigations Team at Veridian Engineering as part of the Advanced Occupant Protection System Study. Specifically, the SCI team was instructed to download the crash data stored in the Restraint Control Module, as a supplement to the crash investigation.

***SUMMARY***

***Crash Site***

This two-vehicle crash occurred during the morning hours of September 2000. It was dawn at the time of the crash and the weather was not a factor. The road surface was dry. The crash occurred at the intersection of a five-lane westbound divided road and a two-lane north/south road. The three center lanes were for westbound through traffic. The inboard and outboard lanes of the westbound road were only for left and right turns, respectively. A standard (red/amber/green) traffic signal controlled the traffic flow through the intersection. The signal was functioning properly at the time of the crash. The speed limit in the area of the crash was 64 km/h (40 mph). **Figure 1** is a lookback view into the intersection.



**Figure 1:** Northeastward view into the intersection.

### ***Pre-crash***

The 2000 Ford Taurus SE was westbound driven by a 22 year old unrestrained male. The vehicle was traveling in the right center lane. A 20 year old unrestrained male and a 17 year old unrestrained male were the front right and right rear passengers, respectively. The 1989 Chevrolet Cavalier was northbound driven by a 28 year old restrained female. The respective vehicles simultaneously entered the intersection without regard to the intersecting traffic. Both driver's indicated to the investigating police officer that their respective traffic signals were green. There were no independent witnesses.

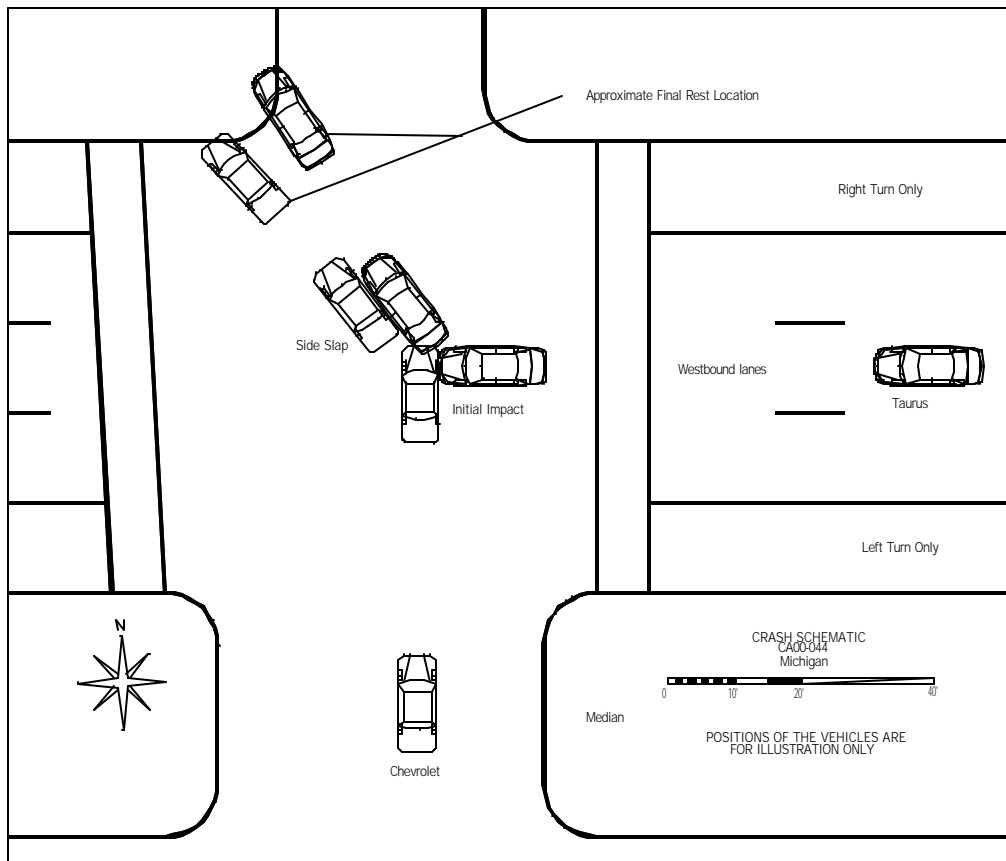
### ***Crash***

The crash occurred with the frontal left area of the Ford striking the forward right side area of the Chevrolet in an L-configuration impact. The Direction of Force was in the 11 o'clock sector for the Ford and 2 o'clock sector for the Chevrolet. Refer to the crash schematic on page 3, **Figure 2**. The total velocity change of the Ford determined by the WINSMASH model was 18.4 km/h (11.4 mph). The longitudinal and lateral delta V components were -15.9 km/h (-9.9 mph) and 9.2 km/h (5.7 mph), respectively. The velocity change of the Chevrolet was 20.9 km/h (13.0 mph). The force of the crash caused the frontal air bags in the Ford to deploy. The Chevrolet was not equipped with an air bag system.

The lateral impact of the Ford, forward of the Chevrolet's center of gravity, caused the Chevrolet to rotate counterclockwise. The northward momentum of the Chevrolet caused the Ford to rotate clockwise. The vehicles contacted again in a secondary side slap with the right side of the Chevrolet striking the left side of the Ford. The resultant direction of forces were 3 and 9 o'clock for the Chevrolet and Ford, respectively. Both vehicles then slid to rest in the northwest quadrant of the intersection. Their exact final rest positions were not documented by the police.

### ***Post-crash***

The police and EMS personnel responded to the scene. The unrestrained driver of the Ford was not injured in the crash. He was cited for driving while impaired. His Blood Alcohol Content (BAC) measured 0.11. The unrestrained front right occupant in the Ford suffered a police reported non-incapacitating injury. He did not require medical treatment. The Taurus SE's unrestrained right rear occupant sustained a reported non-incapacitating injury and was transported to a local hospital. The restrained driver of the Chevrolet had a complaint of pain but refused medical treatment. Both vehicles were towed due to disabling damage.



**Figure 2:** Crash schematic.

***VEHICLE DATA***

***2000 FORD TAURUS SE***

The 2000 Ford Taurus SE was identified by the Vehicle Identification Number (VIN): 1FAFP53U2YG (production sequence deleted). The vehicle’s power train consisted of a 3.0 liter, V-6 engine linked to a 4-speed automatic overdrive transmission. The vehicle had 4-wheel disc brakes. It was not ABS equipped. The cloth trimmed interior was equipped with a power package that included power steering, brakes windows, door locks, and mirrors. The odometer read 17,809 km (11,066 miles) at the time of the inspection.

***Exterior Damage***

**Figure 3** is a left front view of the damaged Taurus SE. The vehicle’s front plane and left side plane sustained direct contact damage as a result of the intersection impact. The frontal direct damage began 21.6 cm (8.5 in) right of center and extended 95.3 cm (37.5 in) to the left corner. The direct damage pattern wrapped around the bumper corner and extended 52.1 cm (20.5 in) along the left side of the vehicle. The crush profile measured along the bumper beam (bumper reinforcement) was as follows: C1=18 cm (7.1 in), C2=16 cm (6.3 in), C3=15 cm (5.9 in), C4=12 cm (4.7 in), C5=8 cm (3.1 in), C6=8



Figure 3: Left front view of the Ford.

cm (3.1 in). The hood was buckled and jammed shut. The windshield was not fractured. The wheelbase measurements were unchanged. The front of the vehicle was shifted approximately 32 cm (12.5 in) to the right. The Collision Deformation Classification was 71-FYEW-1. (The direction of force was incremented by 60 to accommodate the lateral end-shift.) The total velocity change of the Ford determined by the Damage Algorithm of the WINSMASH model was 18.4 km/h (11.4 mph). The longitudinal and lateral delta V components were -15.9 km/h (-9.9 mph) and 9.2 km/h (5.7 mph), respectively.

The left side of the Taurus SE sustained 157 cm (62 in) of direct and induced damage as a result of the secondary side slap, **Figure 4**. The left side damage began 178 cm (70 in) forward of the left rear axle on the left front door and ended 20 cm (8 in) forward of the left rear axle, near the C-pillar location. The maximum lateral deformation measured 8.9 cm (3.5 in). It was located 41 cm (16 in) forward of the left rear axle and was caused by contact with the rear bumper of the Chevrolet's. The side slap impact jammed both left side doors shut and disintegrated the left rear window glazing. The CDC of this impact was 09-LPEW-3.



Figure 4: View of the side slap damage to the Taurus SE.

### ***1989 Chevrolet Cavalier***

The 1989 Chevrolet Cavalier was identified by the Vehicle Identification Number (VIN): 1G1JC5119KJ (production sequence deleted). The 4-door sedan was powered by a 2.0 liter, I-4 engine linked to a 3-speed automatic transmission. It was equipped with front disc/rear drum brakes. The restraint system consisted of manual 3-point lap and shoulder belts for the four outboard seat positions. The center rear position was equipped with a lap belt. The vehicle was not equipped with a Supplemental Restraint System (air bags).

### ***Exterior Damage***

The right side of the Chevrolet sustained two distinct regions of direct contact damage attributed to the crash. The width of the damage resultant to the initial impact measured 165 cm (65 in) and was centered



approximately on the right front axle, **Figure 5**. The damage began at the right corner of the front bumper, extended longitudinally rearward across the right front fender, and terminated at the right A-pillar location. The crush profile at the trim elevation measured as follows: C1=1.2 cm (0.5 in), C2=11 cm (4.3 in), C3=18 cm (7.1 in), C4=18 cm (7.1 in), C5=8 cm (3.1 in), C6=2 cm (1.0 in). The total velocity change of the Chevrolet calculated of the WINSMASH model was 20.9 km/h (13.0 mph). The longitudinal and lateral components of the delta V were -10.4 km/h (-6.5 mph) and -18.1 km/h (-11.2 mph), respectively. The CDC of this damage region was 02-RFEW-3.

The damage resultant to the side slap was located on the right rear quarter of the vehicle, **Figure 6**. The width of the damage measured 109 cm (43 in). It began 23 cm (9 in) forward of the right rear axle and extended to the right rear corner. The maximum lateral deformation measured 5 cm (2 in) and was located at the right rear corner. The CDC of the impact was 03-RBEW-2.



**Figure 5:** Front view of the Chevrolet.



**Figure 6:** Right rear side slap damage.

## ***2000 FORD TAURUS SE***

### ***Advanced Occupant Protection System***

The Advanced Occupant Protection System in the 2000 Ford Taurus SE, designated by the manufacturer as the Personal Safety System (PSS), was a total redesign from earlier model years. The AOPS consisted of the integrated use of manual 3-point lap and shoulder belts with load limiting retractors, buckle pretensioners, driver seat position sensing and dual-stage air bag inflation. The driver and front right passenger air bags were designed to deploy at different thresholds of crash severity dependent on restraint use and seat position. The vehicle was not equipped with side impact air bags. The Restraint Control Module (RCM) located on the vehicle's centerline, under the instrument panel, monitored and controlled the deployment of the vehicle's safety systems. The RCM was capable of recording data related to the crash event. The crash data was downloaded in the field during the SCI inspection. This data was then electronically forwarded to the Safety Office of the Ford Motor Company for analysis. The results of the downloaded data are included as **Attachment A** at the end of this report.

The RCM data indicated the front belt systems were not buckled at the time of the crash and the buckle pre-tensioners did not fire. The driver seat was not adjusted to a forward position and Stage 1 frontal air bag deployments were commanded to fire 19 milliseconds into the crash. (The second stage of the dual stage system was disposed of approximately 100 milliseconds after the stage 1 deployment.) The RCM sensed and recorded the crash acceleration pulse for a duration of 78 milliseconds. The 78 millisecond longitudinal delta V recorded by the RCM was approximately -25.9 km/h (-16.1 mph). The 78 millisecond lateral delta V was approximately 18.5 km/h (11.5 mph).

The vehicle was equipped with 3-point lap and shoulder belt systems in the front outboard seat positions. The front seat belt systems consisted of a continuous loop lap and shoulder belt webbing with a sliding latch plate. The vehicle sensitive/load limiting retractors were located in the base of the B-pillars. The front restraints were also equipped with buckle mounted pre-tensioners. The restraint's D-rings were adjustable. The rear seat was equipped with 3-point lap and shoulder restraints for all three seat positions.

Upon inspection, the driver's restraint webbing was stowed in the retractor and operational. The left front D-ring was adjusted 1.9 cm (0.75 in) above the lowest position. Examination of the webbing and latch plate hardware revealed evidence of historical use. However, there was no evidence on the hardware or the webbing indicative of use during the crash. The driver's buckle pre-tensioner had not fired. The post-crash measurement of the pre-tensioner's piston barrel was 110 mm (4.3 in). Inspection of the driver's belt system indicated the driver was not restrained at the time of the crash.

The front right restraint webbing was stowed and operational at inspection. The webbing and latch plate exhibited historical evidence similar in nature to the driver's restraint. The adjustable right upper anchorage (D-ring) was positioned 5.0 cm (2.0 in) below full up. There was no evidence of loading to the restraint webbing or hardware. The right buckle pre-tensioner had not fired and the piston barrel measured 110 mm (4.3 in). All the evidence identified during the inspection indicated the front right passenger was unrestrained during the crash.

The right rear restraint was stowed and operational. The latch plate exhibited minor evidence of historical use. Inspection of the webbing was unremarkable. The right rear occupant was unrestrained at the time of the crash.

Inspection of the vehicle's interior identified damage consistent with the deployment of the frontal air bag system and minor occupant contact to the interior components. There was no intrusion associated to the exterior crash forces.

The driver seat was adjusted to the full rear position. The top outboard aspect of the front seat back had deformed rearward (clockwise viewed from above) approximately 14.0 cm (5.5 in) from rebound contact. The 4-spoke adjustable steering wheel rim was adjusted to the center position. There was no rim deformation. Inspection of the steering column shear capsules determined there was no shear capsule separation. The bend bracket supporting the mid-aspect of the steering column was undamaged and the shear coupling on the lower aspect of the column was intact. The driver knee bolster exhibited a minor scuff as a result of probable contact with the left lower extremity. The scuff measured 6.4 cm x 1.9 cm (2.5

in x 0.75 in) and was located approximately on the steering column center line. This contact did not result in any injury.

The driver air bag module was located in the center of the steering wheel. The driver air bag (**Figure 7**) had deployed from the H-configuration module cover flaps. The cover flaps opened along the designated tear seams. The height of the upper and lower flaps measured 6.4 cm (2.5 in) and 4.6 cm (1.8 in), respectively. The width of the flaps measured 17.2 cm (6.8 in). The deployed driver air bag measured 53 cm (21 in) in diameter. It was tethered by four straps sewn to the face of the bag. The bag was vented by two 2.9 cm (1.1 in) ports located in the 10/2 o'clock position of the back side of the bag. There was no evidence of occupant contact to the air bag. The following nomenclature identified the air bag:

P5206000-00D TXM00-1251116

The right front seat was adjusted to a rear track position and measured 2.5 cm (1.0 in) forward of full rear. No contact evidence was identified on the right bolster. The front right passenger air bag module was a top mount design located in the right aspect of the instrument panel. The air bag (**Figure 8**) had deployed as designed from the module. The face of the deployed passenger bag measured 58.4 cm x 39.4 cm (23.0 in x 15.5 in), width by height, and extended 46 cm (18 in) from the aft edge of the module. A series of vertical vinyl transfers was located on the lower central aspect of the face of the bag. These transfer marks resulted from contact between the air bag and the edge of the module during the deployment sequence. This transfer pattern had been identified on several other Ford Taurus SE AOPS investigations and was typical of this system's deployment. Further inspection of the passenger air bag was unremarkable. No evidence of occupant contact was identified.



**Figure 7:** View of the deployed driver air bag.



**Figure 8:** View of the deployed front passenger air bag.

## ***OCCUPANT DEMOGRAPHICS***

	Driver	Front right passenger
Age/Sex:	22 year old/Male	20 year old/Male
Height/Weight:	Unknown	Unknown
Restraint Use:	Unrestrained	Unrestrained
Usage Source:	SCI inspection, RCM	SCI inspection, RCM
Medical Treatment:	None	None

	Left rear passenger	Right rear passenger
Age/Sex:	n/a	17 year old/Male
Height/Weight:	n/a	Unknown
Restraint Use:	n/a	Unrestrained
Usage Source:	n/a	SCI inspection
Medical Treatment:	n/a	Treated and released

## ***OCCUPANT KINEMATICS***

### ***Driver***

Immediately prior to the crash, the unrestrained driver of the Ford Taurus SE was seated with a presumed normal posture in the full rear seat track position. At impact, the driver responded to the 11 o'clock direction of the impact by initiating a forward trajectory. The driver's upper torso contacted the deployed air bag and his lower extremities contacted the knee bolster. The deployed air bag protected the driver and prevented significant contact with the forward interior.

As the vehicles impacted in the side slap configuration, the driver responded to the 9 o'clock impact force by translating to the left. He was also beginning to rebound rearward at this time. The left rearward trajectory displaced the driver into, and deformed the outboard aspect of the seat back. He then came to rest within the confines of the seat. He was not injured in the event.

### ***Front Right Passenger***

Prior to the crash, the front right passenger was unrestrained with his seat adjusted to a rear track position. At impact, the passenger initiated a forward trajectory in response to the 11 o'clock direction of the impact

and contacted the deployed passenger air bag. The deployed air bag provided the passenger protection and prevented injury.

The vehicles impacted a second time in a side slap configuration with a 9 o'clock direction of force. The passenger responded to the impact by translating left. He was also initiating a rearward rebound at this time. The left rearward trajectory displaced the passenger toward the center of the vehicle. He probably contacted the center console and may have interacted with the driver. The passenger suffered a police reported non-incapacitating injury, however, the passenger was not transported for treatment.

### ***Right Rear Passenger***

The right rear passenger was unrestrained at the time of the impact. His exact position and posture were unknown. At impact, the passenger initiated a forward trajectory and probably contacted the right front seat back. No evidence to support this contact was identified during the inspection. As the passenger began his rebound trajectory, the vehicle's impacted in the secondary side slap. The 9 o'clock direction of the impact probably displaced the unrestrained passenger into contact with the left rear door. Contact with the left rear door was the possible source of his police reported non-incapacitating injury.

# ATTACHMENT A

CA00-044.hex



## 2000 Taurus/Sable EDR Report - Summary Page

### Investigation Data

File Name:	CA00-044.hex	File Save Date:	10-Nov-2000
File Read-out Date:	N/A	Report Date:	11-Dec-2000
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:	19
Time From Algorithm Wakeup to First Stage - Belted:	23
Time From Algorithm Wakeup to Second Stage:	0

### Restraint System Status

Driver Seat Belt Buckle:	Not Engaged
Passenger Seat Belt Buckle:	Not Engaged
Driver Seat Track In Forward Position:	No
Passenger Seat Weight Switch Position:	N/A

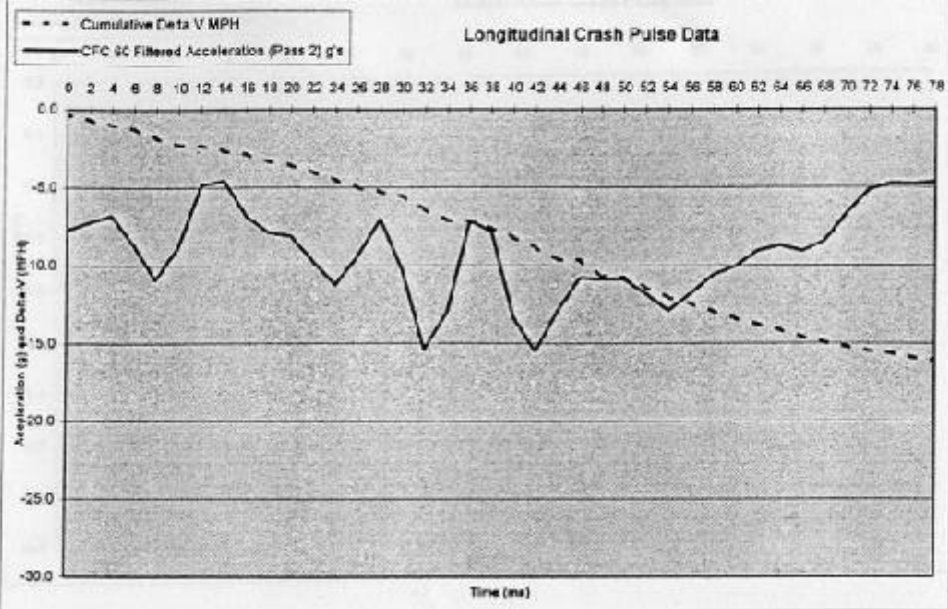
### Deployment Initiation Attempt Times

	Driver	Passenger
Time From Algorithm Wakeup to Pretensioner Deployment Attempt:	Unbelted	Unbelted
Time From Algorithm Wakeup to First Stage Deployment Attempt:	19	19
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Disposal	Disposal

### Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	-0.3	-2.3	-3.6	-5.6	-6.2	-10.7	-13.4	-15.2	-15.1

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	1.7	2.1	2.9	4.3	7.1	10.2	11.5

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

