

**TRANSPORTATION SCIENCES  
CRASH DATA RESEARCH CENTER**

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**ADVANCED OCCUPANT PROTECTION SYSTEM STUDY  
2001 FORD TAURUS INVESTIGATION**

**VERIDIAN CASE NO. CA01-033**

**LOCATION - MICHIGAN**

**CRASH DATE - APRIL 2001**

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

**Prepared for:**

**U.S. Department of Transportation  
National Highway Traffic Safety Administration  
Washington, DC 20590**

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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.

## TECHNICAL REPORT STANDARD TITLE PAGE

<p>1. <i>Report No.</i> CA01-033</p>	<p>2. <i>Government Accession No.</i></p>	<p>3. <i>Recipient's Catalog No.</i></p>	
<p>5. <i>Title and Subtitle</i> Advanced Occupant Protection System Study Vehicle - 2001 Ford Taurus Location - Michigan</p>		<p>4. <i>Weights</i></p>	
		<p>6. <i>Report Date:</i> February 2002</p>	
<p>8. <i>Author(s)</i> Crash Data Research Center</p>		<p>7. <i>Performing Organization Code</i></p>	
		<p>9. <i>Performing Organization Report No.</i></p>	
<p>10. <i>Performing Organization Name and Address</i> Transportation Sciences Crash Data Research Center Veridian Engineering P.O. Box 400 Buffalo, New York 14225</p>		<p>11. <i>Work Unit No.</i> CO1115.0365.(0000-9999)</p>	
		<p>12. <i>Contract or Grant No.</i> DTNH22-94-D-07058</p>	
<p>13. <i>Sponsoring Agency Name and Address</i> U.S. Department of Transportation National Highway Traffic Safety Administration Washington, DC 20590</p>		<p>14. <i>Type of Report and Period Covered</i> Technical Report Crash Date: April 2001</p>	
		<p>15. <i>Sponsoring Agency Code</i></p>	
<p>16. <i>Supplementary Notes:</i> On-site investigation of a 2001 Ford Taurus equipped with an Advanced Occupant Protection System.</p>			
<p>17. <i>Abstract</i></p> <p>This on-site investigation focused on the performance of the Advanced Occupant Protection System in the 2001 Ford Taurus. The AOPS consisted of the integrated use of 3-point lap and shoulder belts, 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 dependant on restraint use and driver seat position. The subject 2001 Ford Taurus departed the right side of the road, traveled down an embankment, and struck a highway sign with the right side of the vehicle. The force of the impact caused the deployment of the vehicle's frontal air bags. The 25 year old male driver was unrestrained and suffered a forehead laceration. He was transported to a local hospital for treatment and released.</p> <p>This crash was identified through the weekly sampling of Police Reports conducted by the General Estimates System (GES). NASS Zone Center 1 relayed the crash notification to the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA). NHTSA subsequently 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. The vehicle was located at a storage facility local to the crash site and was available for inspection. The crash data stored in the vehicle's Restraint Control Module was downloaded as a supplement to the crash investigation.</p>			
<p>18. <i>Key Words</i> Advanced Occupant Protection System Frontal air bags Pretensioner, Restraint Control Module Minor injury</p>		<p>19. <i>Distribution Statement</i> General Public</p>	
<p>20. <i>Security Classif. (of this report)</i> Unclassified</p>	<p>21. <i>Security Classif. (of this page)</i> Unclassified</p>	<p>22. <i>No. of Pages</i> 11</p>	<p>23. <i>Price</i></p>

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**ADVANCED OCCUPANT PROTECTION SYSTEM STUDY  
2001 FORD TAURUS**

**VERIDIAN CASE NO: CA01-033  
LOCATION: MICHIGAN  
CRASH DATE: APRIL, 2001**

***BACKGROUND***

This on-site investigation focused on the performance of the Advanced Occupant Protection system (AOPS) in the 2001 Ford Taurus. The AOPS consisted of the integrated use of 3-point lap and shoulder belts, buckle pretensioners, 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 dependant on restraint use and seat position. The subject 2001 Ford Taurus departed the right side of the road, traveled down an embankment, and struck a highway sign with the right side of the vehicle. The force of the impact caused the deployment of the vehicle's frontal air bags. The 25 year old male driver was unrestrained and suffered a forehead laceration injury. He was transported to a local hospital for treatment and released.

This crash was identified through the weekly sampling of Police Accident Reports conducted by the General Estimates System (GES). NASS Zone Center 1 relayed the crash notification to the Crash Investigations Division of the National Highway Traffic Safety Administration (NHTSA). NHTSA subsequently 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. The vehicle was located at a storage facility local to the crash site and was available for inspection. The crash data stored in the vehicle's Restraint Control Module was downloaded as a supplement to the crash investigation.

***SUMMARY***

***Crash Site***

This single-vehicle roadside departure crash occurred during the nighttime hours of April, 2001. At the time of the crash, it was dark, without overhead lighting, and the weather was not a factor. The road surface was dry. The crash occurred on the south roadside of a four-lane divided east/west state route in a suburban setting. There was a large radius left curve for eastbound traffic at the crash site. A 2.7 m (9.0 ft) wide breakdown lane bordered the outboard lane. The south roadside terrain sloped away from the traffic lanes with an approximate grade of 20 percent over 3 m (10 ft) and then became level. The non-breakaway support structure for an overhead highway sign was located approximately 10.4 m (34 ft) south of the outboard edge of the traffic lane and was the point of impact. The speed limit in the area of the crash was 105 km/h (65 mph). **Figures 1 and 2** are an eastbound approach view of the Ford Taurus and a westward look back from the area of final rest, respectively.



Figure 1: Approach view of the Ford Taurus.



Figure 2: Look back view from final rest.

### *Pre-crash*

The 2001 Ford Taurus was driven by a 25 year old unrestrained male. The vehicle was eastbound in the outboard lane of the highway traversing the shallow left curve. The driver reported he fell asleep relinquishing directional control of the vehicle. The Ford drove out of the curve and departed the right side of the road. The vehicle traveled down an embankment and into a ditch that paralleled the highway. The driver was probably startled awake by these off-road dynamics and attempted to steer the vehicle to the left (counterclockwise) to regain the roadway. The support structure of an overhead highway sign was located in the base of the ditch and was the point of impact.

Evidence of the vehicle's trajectory had deteriorated due to the delay in crash notification and the growth of vegetation at the scene. Vehicle debris (including the exterior sheet metal of the right front door) was found in the ditch and paint transfers on the support post identified the point of impact. **Figure 3** is a schematic of the crash depicting the vehicle's approximate trajectory.

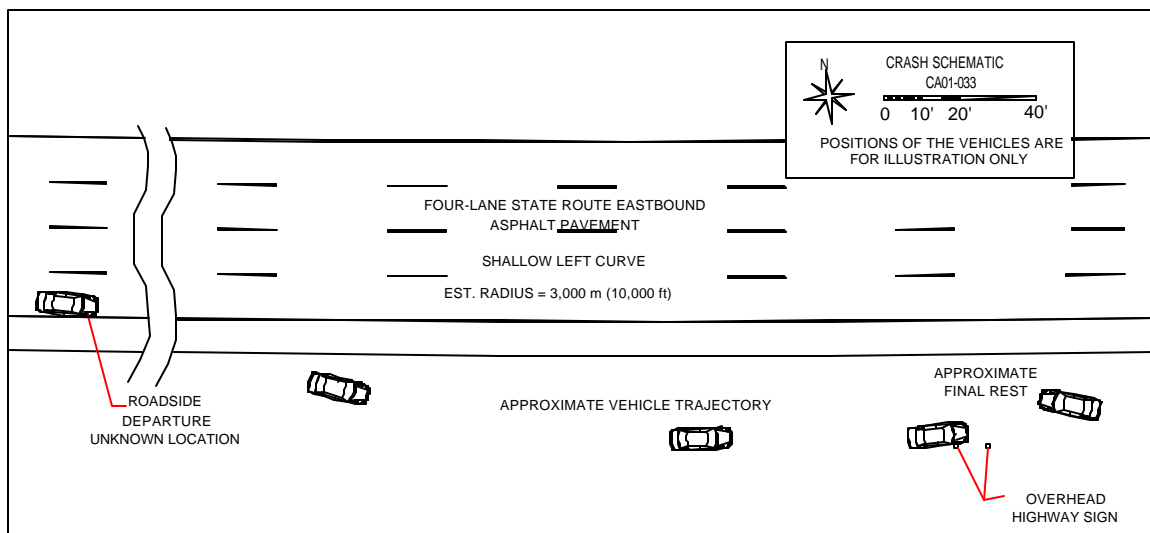


Figure 3: Crash schematic.

### ***Crash***

The Ford Taurus initially impacted the 25 cm x 25 cm (10 in x 10 in) support post with the right side of the vehicle in a sideswiping manner. The right side contact with the post began at the leading aspect of the right front door and extended rearward. As the vehicle continued on its eastward trajectory, its interaction with the post increased until the post pocketed the side structure and engaged the right rear suspension. The engagement with the right rear suspension caused the deployment of the vehicle's frontal air bag system. The force of the impact compromised the right C-pillar, and separated the right rear suspension components and right rear quarter from the vehicle's central uni-body structure, refer to **Figures 4 and 5**. Analysis of this impact damage was beyond the scope of the WINSMASH collision model. The delta V of this impact was in excess of 25.0 km/h (15.5 mph) and had a long duration. The vehicle then rotated approximately 180 degrees clockwise and came to rest facing westward. The left front corner of the vehicle contacted and over-rode an 8 cm (3 in) diameter sapling prior to coming to rest.



**Figure 4:** Right side view of the Taurus.



**Figure 5:** Taurus right rear quarter damage.

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

The police and EMS services responded to the scene. The driver of the Ford reportedly exited the vehicle and was seated at the roadside upon their arrival. The driver had no recollection of the crash. The police investigation revealed the driver was alcohol impaired. The police reported that the driver sustained an incapacitating injury and was transported to a local hospital. The insurance carrier for the vehicle reported the driver sustained a head laceration in the crash.

## **2001 FORD TAURUS**

The 2001 Ford Taurus SE, **Figure 6**, was identified by the Vehicle Identification Number (VIN): 1FAPP53U71G (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 was equipped with 4-wheel disc brakes. The cloth trimmed interior was equipped with a power package that included power steering, brakes, windows, door locks, and mirrors. The driver's seat was adjusted manually. The driver's foot controls were not adjustable. The subject vehicle was equipped with frontal air bags for the driver and front right passenger. The 4-door sedan was manufactured in March 2001. The odometer read 3,312 km (2,058 miles) at the time of the inspection.



**Figure 6:** Right front view of the Ford Taurus.

### ***Exterior Damage***

The right front wheel rim and wheel well was caked with mud and debris from its off-road trajectory. The tire was deflated. The right side sideswiping direct contact damage began 41.9 cm (16.5 in) aft of the right front axle on the forward aspect of the right front door. The exterior panel of the right front door deformed and was displaced from the vehicle. It was found at the crash scene, as previously mentioned. The right front window glazing disintegrated.

This contact pattern continued rearward along the right side toward the C-pillar as the vehicle's momentum carried it eastward. Coincident to this movement, the vehicle's heading was changing counterclockwise. The effect of these dynamics was to increase the magnitude of the direct contact as the PDOF moved into the 1 o'clock sector. As the crash sequence continued the interference pattern between the vehicle and sign post buckled the roof and comprised the C-pillar. The sign post impacted the right rear wheel fracturing the suspension. The right rear wheel rim displayed evidence of direct impact, **Figure 7**. The force of the impact separated the right rear wheel and suspension components, quarterpanel and trunk lid from the vehicle, **Figure 8**. The Collision Deformation Classification (CDC) of this impact was 01-RZAW-4. The vehicle's damage was beyond the scope for analysis utilizing the WINSMASH collision model. The vehicle dynamics and nature of the damage indicate that the crash pulse had a long duration. The delta V of the impact was in excess of 25.0 km/h (15.5 mph) and warranted deployment of the vehicle's frontal air bags.





**Figure 7:** Right rear wheel impact damage.



**Figure 8:** Components dislodged due to the force of the impact.

The left side of the Ford Taurus was relatively undamaged. During the vehicle's post impact rotation to final rest, it impacted a small sapling with the left front corner (side). The impact fractured the left corner of the bumper fascia, buckled the fender and fractured the left headlamp. The contact pattern measured 25 cm (10 in) in length and had a depth of approximately 10 cm (4 in). The CDC was 11-LFEN-1. The left wheelbase was unchanged. The left doors were operational and the side glazings were intact. The windshield was fractured. It had sagged from its mounting due to its exposure to the elements.

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

The Advanced Occupant Protection System in the 2001 Ford Taurus was designated by the manufacturer as the Personal Safety System (PSS). 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 driver seat position. The subject vehicle was not equipped with side impact protection. 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 unbuckled at the time of the crash and the buckle pretensioners did not fire. The driver seat was not adjusted to a forward position. A Stage 1 frontal air bag deployment was commanded 87 milliseconds after algorithm wakeup. The second stage of the dual-stage frontal bags was disposed of (deployed) approximately 100 milliseconds after Stage 1. The RCM continuously sensed and then recorded the crash acceleration pulse for a duration of 78 milliseconds. The 78 millisecond longitudinal delta V recorded by the RCM was approximately -21.9 km/h (-13.6 mph).

The 78 millisecond lateral delta V was approximately -4.3 km/h (-2.7 mph). Analysis of the acceleration pulse and velocity curves indicated that only a portion of this long duration crash event was recorded. The acceleration traces were still active and the velocity curves were still rising at the termination of the recording.

### *Interior Damage*

The integrity of the driver's occupant space was intact. There was no intrusion into the driver's area. A 2.5 cm x 2.5 cm (1.0 in x 1.0 in) area scuff was noted on the right upper aspect of the knee bolster. The scuff was located 11.4 cm (4.5 in) right of the steering column and was attributed to a right lower extremity contact. This contact did not produce any injury. The rear view mirror was displaced from its mounting and found on the left side of the instrument panel, forward of the driver. The center console was impacted and rotated to the right approximately 3.8 cm (1.5 in) from a right upper extremity contact, **Figure 9**. Post-crash blood evidence was noted on the center console right front seat cushion, and driver air bag.



**Figure 9:** Front interior view and center console deformation.

The manual driver seat was adjusted to the full forward position upon inspection. The RCM recorded that the seat was not in a forward position. The forward position is referenced to a position between 0 cm - 10 cm (0 in - 4 in) rearward of full. The seat track travel was 25 cm (10 in). Therefore, the driver seat was adjusted to a mid or rear track position at the time of the crash.

The 4-spoke adjustable steering wheel rim was set 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 and the shear coupling on the lower aspect of the column were not damaged and intact.

The right side of the vehicle sustained approximately 28 cm (11 in) of right B-pillar intrusion measured at the D-ring elevation. The right rear door, rear seat back and package shelf were missing, having been separated in the impact.

The Taurus 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 pretensioners. 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 within the retractor and the retractor was operational. The left front D-ring was adjusted to the full up position. Inspection of the driver's belt found minimal historical usage evidence on the latch plate and the webbing was evidence free. There was no evidence on the hard surfaces of the latch plate or D-ring indicative of use during the crash. The driver's buckle pretensioner had not fired, **Figure 10**. The post-crash measurement of the pretensioner's piston barrel measured 110 mm (4.3 in). This measurement was the pretensioner's unfired specification. All the evidence identified during the inspection indicated the driver was unrestrained at the time of the crash.



**Figure 10:** Driver's unfired buckle pretensioner.

The driver air bag module was configured in the typical manner and located in the center of the steering wheel. The driver air bag had deployed from the H-configuration module cover flaps, **Figure 11**. 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 on the back side of the bag. Post-crash blood evidence was concentrated in the 6 to 7 o'clock sector, with minor spattering noted in the 11 o'clock sector. The following nomenclature identified the air bag: P5206000-00E TXM010476255.



**Figure 11:** Driver air bag.

The front right passenger air bag module was a top mount design located in the right aspect of the instrument panel. The air bag 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. The upper surface of the air bag's membrane exhibited multiple small dicing-type lacerations due to contact with the fractured windshield.

### ***OCCUPANT DEMOGRAPHICS***

	<b>Driver</b>
Age/Sex:	25 year old/Male
Height/weight:	Unknown
Restraint Use:	None
Usage Source:	SCI inspection, RCM
Medical Treatment:	Treated and released

### ***DRIVER INJURY***

<b>Injury</b>	<b>Severity (AIS 98 update)</b>	<b>Injury Mechanism</b>
Forehead laceration, NFS	Minor (290600.1,7)	Probable windshield/center mirror contact

*Note: the above injury was identified through the insurance carrier for the subject vehicle.*

### ***DRIVER KINEMATICS***

The 25 year old male driver was unrestrained and had fallen asleep immediately prior to the crash. The police investigation determined his blood alcohol content (BAC) was above the legal limit. The driver relinquished directional control of the vehicle and it departed the right side of the highway. As a result of the Ford's off-road trajectory, the driver was probably startled awake and steered the vehicle back to the left. During this maneuver, the right side of the Taurus contacted and sideswiped an overhead sign support post. The engagement with the post continued rearward along the right side and the magnitude of the vehicle's interaction with the post increased. The support post pocketed into the area of the right rear suspension causing the deployment of the vehicle's frontal air bags. The force direction of this engagement was in the 1 o'clock sector.

The unrestrained driver responded to the initial sideswiping impact by exhibiting a forward trajectory. The driver's right lower extremity contacted the knee bolster evidenced by the bolster scuff. The driver then moved rightward into contact with the center console, as the PDOF moved into the 1 o'clock sector near maximum engagement. The driver's upper torso was arching forward and over the center console as his lower extremities came into contact with these interior components. The driver's head contacted the rear view mirror and/or windshield causing a laceration.

The driver probably had little involvement with the deploying air bags due to his right offset position. The air bags deployed late in the crash sequence as a result of the unique crash dynamics. The late deployment allowed the driver to become out-of-position.

As the vehicle rotated to final rest, the driver rebounded back into his seat. He remained in the vehicle for an unknown time period prior to his exit, as evidenced by the post-crash blood deposits on the center console and driver air bag. He then exited the vehicle, climbed up to the road side and sat down where he was found by the investigating police officer.

## ATTACHMENT A

Investigation Data	
File Name: ca01-033.hex	File Save Date: 14-Jun-2001
File Read-out Date: N/A	Report Date: 15-Jun-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	ms
Time From Algorithm Wakeup to Pretensioner:	87
Time From Algorithm Wakeup to First Stage - Unbelted:	87
Time From Algorithm Wakeup to First Stage - Belted:	0
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:	87	87
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Disposal	Disposal

Figure 12: RCM Summary Page

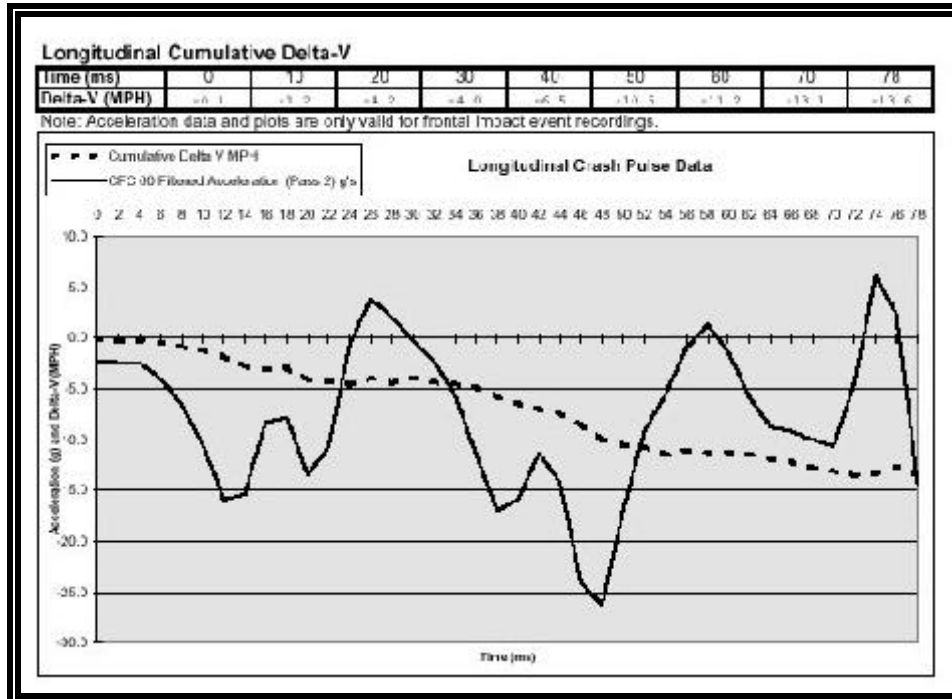


Figure 13: Longitudinal Delta V.

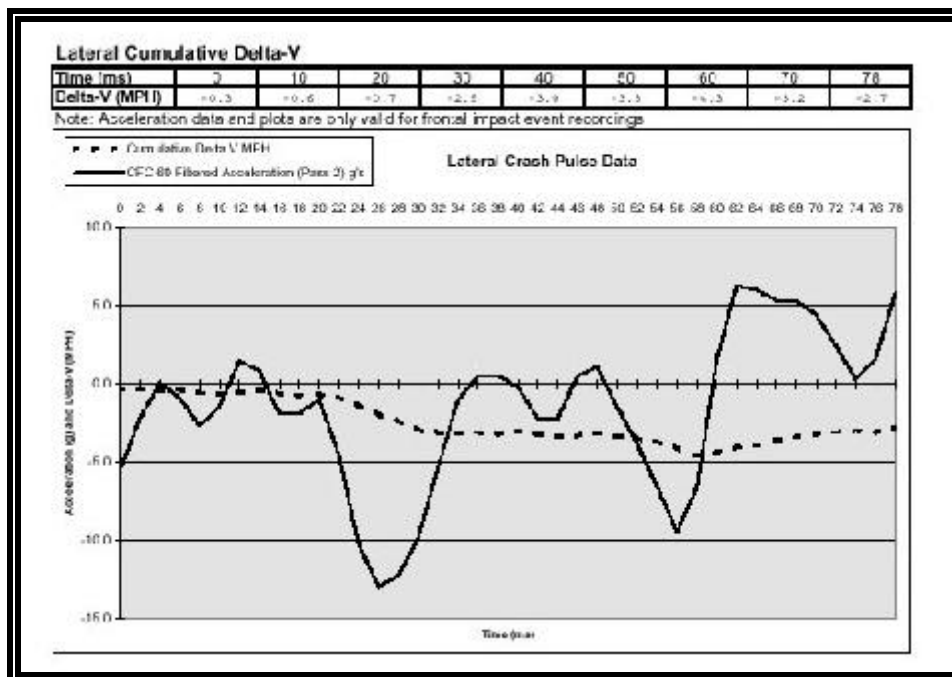


Figure 14: Lateral Delta V.