On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS00-017
2000 Ford Taurus SE station wagon
Oregon
June, 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

This case was initiated because the case vehicle was equipped with an advanced air bag protection system. The collision occurred in Oregon in June 2000 at 1500 hours. At the point of impact the roadway is a two way, five lane, undivided, straight and level asphalt roadway. The posted speed limit for both directions of travel is 72 km/h (45 mph), and there were no traffic controls present. The weather was clear and the roadway was dry. There were no obstructions or roadway defects reported. The case vehicle is a fleet (rental) vehicle, a 2000 Ford Taurus SE station wagon that was driven by a restrained 50-year-old male. The case vehicle was northbound in the second lane from the center line at a police estimated 72 km/h (45 mph) travel speed. The other vehicle is a 1994 Chevrolet C1500 ½ ton Super Cab pickup that was driven by a restrained 75-year-old male. The front right seat was occupied by a restrained female. The Chevrolet was traveling southbound in the far right lane at a police estimated 72 km/h (45 mph) travel speed.

A non-contact vehicle turned left in front of the case vehicle. The driver of the case vehicle applied the brakes hard and the case vehicle began to skid sideways. The driver of the case vehicle lost control of the vehicle and crossed four lanes of traffic directly into the path of the Chevrolet. The front of the case vehicle (12FDEW1) struck the front of Chevrolet in a head-on configuration. On impact, both frontal air bags in the case vehicle deployed, as did the driver's seat belt pretensioner. At impact the case vehicle sustained a total delta v of 31.9 km/h (19.8 mph), a longitudinal delta v of -31.4 km/h (-19.5 mph) and a latitudinal delta v of -5.5 km/h (-3.4 mph). The driver of the case vehicle sustained a contusion to his forehead due to interaction between his glasses and the deployed air bag, and a contusion to his left shoulder from the seat belt. The case vehicle sustained total damage to the front end and was declared a total loss by the insurance company. The police report indicated extensive front end damage at over $1,000.00 to the Chevrolet. Both vehicles were towed from the scene.

17. Key Words	18. Distribution Statement
Air bag, deployment, minor injury, advanced occupant protection, AOPS	

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Dynamic Science, Inc.
Accident Investigation
Case Number: DS00-017

TABLE OF CONTENTS

BACKGROUND:

Description:	This Advanced Occupant Protection Systems case was generated by DSI through existing insurance contacts. NHTSA was notified of the case on September 20, 2000. DSI was assigned the case on September 20, 2000 and an on-site investigation was conducted. All field work was completed on September 22, 2000.
Investigation Type:	On-Scene
Crash Location:	Oregon
Crash Date:	June, 2000
Notification Date:	September 20, 2000
Field Work Completed:	September 22, 2000

SUMMARY:

The collision occurred in Oregon in June 2000 at 1500 hours. At the point of impact the roadway is a two way, five lane, undivided, straight and level asphalt roadway. There are two lanes for northbound traffic, two lanes for southbound traffic and a common left turn lane. The posted speed limit for both directions of travel is 72 km/h (45 mph), and there were no traffic controls present. The weather was clear and the roadway was dry. There were no obstructions or roadway defects reported.

Figure 1. Path of case vehicle, northbound

Figure 2. Path of case vehicle as it veers to the left.

The case vehicle is a fleet (rental) vehicle, a 2000 Ford Taurus SE station wagon that was driven by a restrained[1] 50-year-old male (188 cm/74 in., 91 kg/200 lbs.). The case vehicle was northbound in the second lane from the center line at a police estimated 72 km/h (45 mph) travel speed. The other vehicle is a 1994 Chevrolet C1500 ½ ton Super Cab pickup that was driven by a restrained 75-year-old male. The front right seat was occupied by a restrained female. The Chevrolet was traveling southbound in the far right lane at a police estimated 72 km/h (45 mph) travel speed.

Figure 3. Right front, case vehicle.

The driver of the case vehicle and a witness stated to the police that a non-contact vehicle turned left in front of the case vehicle. The driver of the case vehicle applied the brakes hard and the case vehicle began to skid sideways. The driver of the case vehicle lost control of the vehicle and crossed four lanes of traffic directly into the path of the Chevrolet. The front of the case vehicle (12FDEW1) struck the front of Chevrolet in a head-on configuration. On impact, both frontal air bags in the case vehicle deployed, as did the driver's seat belt pretensioner. At impact the case vehicle sustained a total delta v of 31.9 km/h (19.8 mph), a longitudinal delta v of -31.4 km/h (-19.5 mph) and a latitudinal delta v of -5.5 km/h (-3.4 mph) as computed by WinSmash[2]. The results fit the collision model, but the results appear high.

The driver of the case vehicle sustained a contusion to his forehead due to interaction between his glasses and the deployed air bag, and a contusion to his left shoulder from the seat belt.

[1] The EDR report indicated that the seat belt buckle was "engaged".

[2] Calculated with WinSmash version 2.06, Missing Vehicle algorithm using NCAP derived crush stiffness values.

The driver of the Chevrolet did not report any injuries. The front right occupant sustained contusions across her abdomen from the seat belt and a fractured right hand. The front right occupant of the Chevrolet was transported via ambulance to a hospital where she received medical treatment and was released four hours later. She also underwent 2-plus months of physical therapy for the hand.

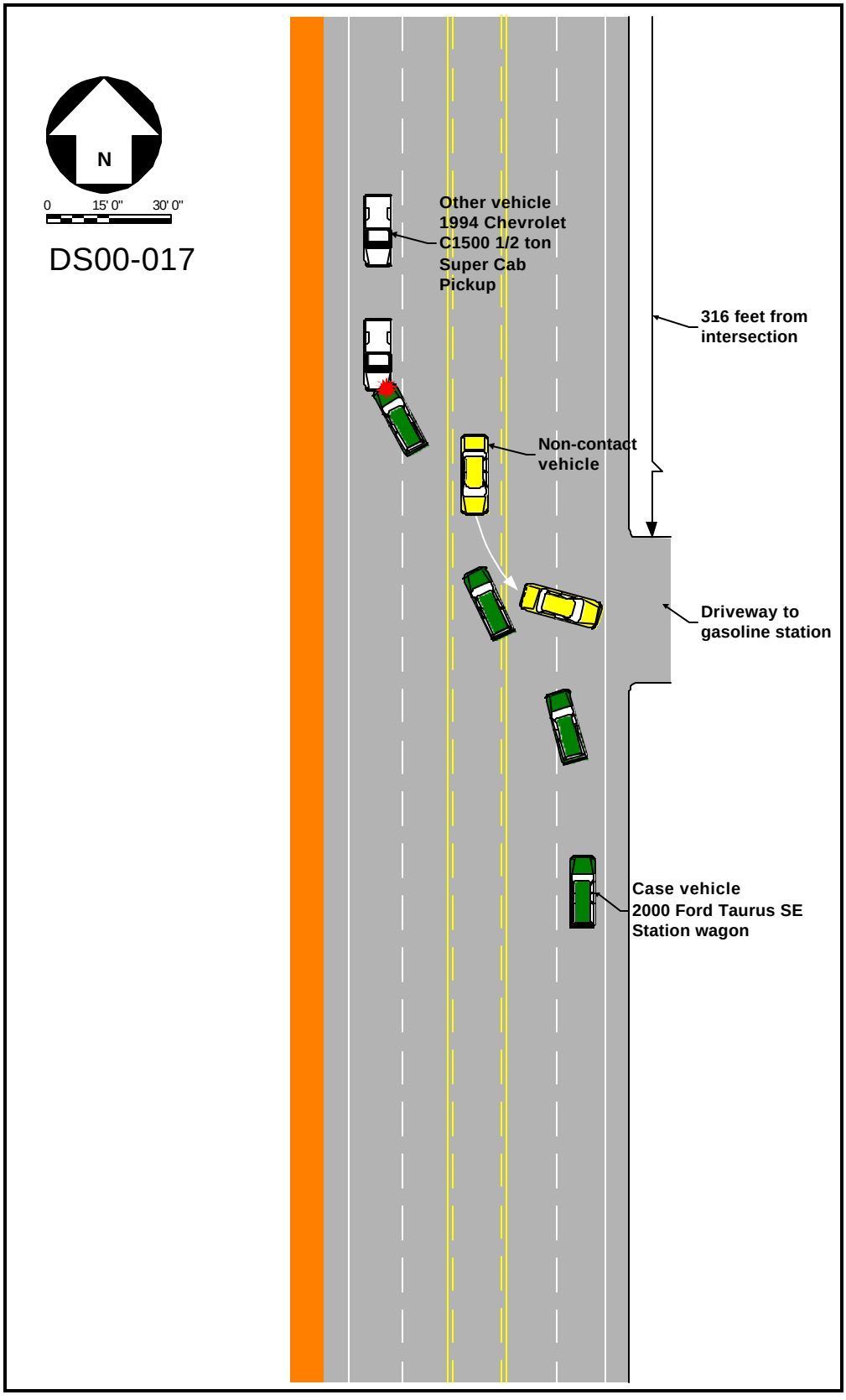
The 2nd seat back cushion was deformed forward. It appears that there was cargo behind the 2nd seat and it moved forward on impact. It does not appear that this played any role in the crash.

The case vehicle sustained total damage to the front end and was declared a total loss by the insurance company. The police report indicated extensive front end damage at over $1,000.00 to the Chevrolet. Both vehicles were towed from the scene.

Figure 4. Driver's seat, case vehicle.

Figure 5. Interior, case vehicle.

Scene diagram



DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2000 Ford Taurus SE station wagon	
VIN:	1FAFP582XYGxxxxxx	
Odometer:	6,949 km/h (4,318 miles)	
Engine:	3.0L, 6 cyl.	
Reported Defects:	None	
Cargo:	None found during inspection, however damage to rear seat was likely as a result of some cargo striking the rear of the rear seat.	
Damage Description:	Moderate frontal crush to bumper, grille, and hood.	
CDC:	12FDEW1	
Delta V:	Total	31.9 km/h (19.8 mph)
	Longitudinal	-31.4 km/h (-19.5 mph)
	Latitudinal	-5.4 km/h (-3.4 mph)
	Energy	32,901 joules (24,266) ft-lbs

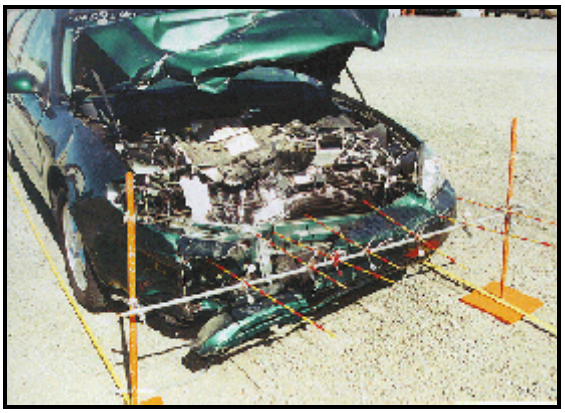


Figure 7. Front right, case vehicle.

Figure 8. Right side, case 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 accerleration. 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 31.9 km/h (19.8 mph), a longitudinal delta v of -31.4 km/h (-19.5 mph) and a latitudinal delta v of -5.4 km/h (–3.4 mph) as computed by WinSmash. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -24.6 km/h (-15.3 mph) and a cumulative lateral delta v of 3.5 km/h (-2.2 mph) at the 78 ms mark. It appears that the pulse had peaked and was declining at this point. 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. The front right front seat buckle was not engaged.
4. The time from algorithm wake-up to pretensioner was 15 milliseconds. The driver's pretensioner did fire.
5. The time from algorithm wake-up to first stage - belted was 25 milliseconds.

The case vehicle was equipped with frontal air bags mounted in the steering wheel and top mounted in the instrument panel of the front right seat position. The driver's air bag had been cut off prior to the vehicle's inspection. The module cover opened in an "H" configuration. There were no indications of any damage to the covers. The front right occupant's frontal air bag had been cut off prior to its inspection. The single flap module did not sustain any damage.

The case vehicle was also equipped with seat belt pretensioners at the front left and front right seating positions. The pretensioner barrels were checked and measured 6 cm (2.4 in.) at the front left seating position and 11 cm (4.3 in) at the front right seating position. This indicated that the driver's side pretensioner had deployed and the front right passenger's did not.

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

Other vehicle

Description:	1994 Chevrolet C1500 ½ ton Super Cab pickup	
VIN:	Unknown	
Odometer:	Unknown	
Engine:	Unknown	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Police estimate damage in excess of $1000. Their damage diagram shows contact primarily to the left front. Vehicle was towed from the scene due to damage.	
CDC:	Unknown	
Delta V:	Total	26.4 km/h (16.4 mph)
	Longitudinal	-26.0 km/h (-16.2 mph)
	Latitudinal	4.6 km/h (2.9 mph)
	Energy	95,871 joules (70,711 ft-lbs)

Occupants

Case vehicle	Occupant 1
Age/Sex:	50/Male
Seated Position:	Front left
Seat Type:	Cloth covered, bucket seat--adjusted to rear most track position
Height:	157 cm (74 in.)
Weight:	91 kg (200 lbs.)
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	> 30 years
Body Posture:	Normal, upright
Hand Position:	Both on wheel. Steering to the left.
Foot Position:	Right foot on brake, left on floor board.
Restraint Usage:	Lap and shoulder belt used
Air bag:	Driver's steering wheel mounted air bag deployed.

Other vehicle

Age/Sex:	75/Male	Unknown age/Female
Seated Position:	Front left	Front right
Seat Type:	Unknown	Unknown
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Presumed to be retired	Unknown
Pre-existing Medical Condition:	Unknown	Unknown
Alcohol/Drug Involvement:	None	None
Driving Experience:	Unknown	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Unknown	Unknown
Restraint Usage:	Lap and shoulder belt used, per police	Lap and shoulder belt used, per police

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Contusion, forehead	290402.1,7	920.0	Air bag / glasses
	Contusion, left shoulder	790402.1,2	923.0	Shoulder harness

Other vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	No reported injuries			
Front right occupant:	Abdominal contusions	590402.1,4	922.2	Seat belt
	Fracture, right hand	751800.2,1	815.0	Unknown

Occupant Kinematics

Figure 9. Displaced plastic knee bolster.

The driver of the case vehicle was seated in a normal, upright fashion. He was wearing glasses at the time of the crash. The glasses had plastic lenses and a metal frame. The driver was using the available lap and shoulder belt. The upper anchorage adjustment was in the full up position. The fabric-covered bucket seat was adjusted to rear most track position. The seat back angle was slightly reclined rearward. As the case vehicle crashed head-on into the Chevrolet, the driver of the case vehicle responded to the 10 degrees direction of principal force by moving forward. The driver's side seat belt pretensioner fired and tightened the seat belt. The driver sustained a minor contusion to his left shoulder from the seat belt. The driver moved forward and contacted the left instrument panel with his left leg–the rigid plastic knee bolster cover was displaced. There was no evidence of loading on the steering column; there was no indications of shear capsule movement. The driver engaged the deployed air bag with his face. This caused his glasses to move upward across the middle part of his forehead–causing a small contusion.

Attachment 1. EDR Report

Investigation Data

File Name:	DS00-017.hex	File Save Date:	27-Sep-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:	15
Time From Algorithm Wakeup to First Stage - Unbelted:	24
Time From Algorithm Wakeup to First Stage - Belted:	25
Time From Algorithm Wakeup to Second Stage:	0

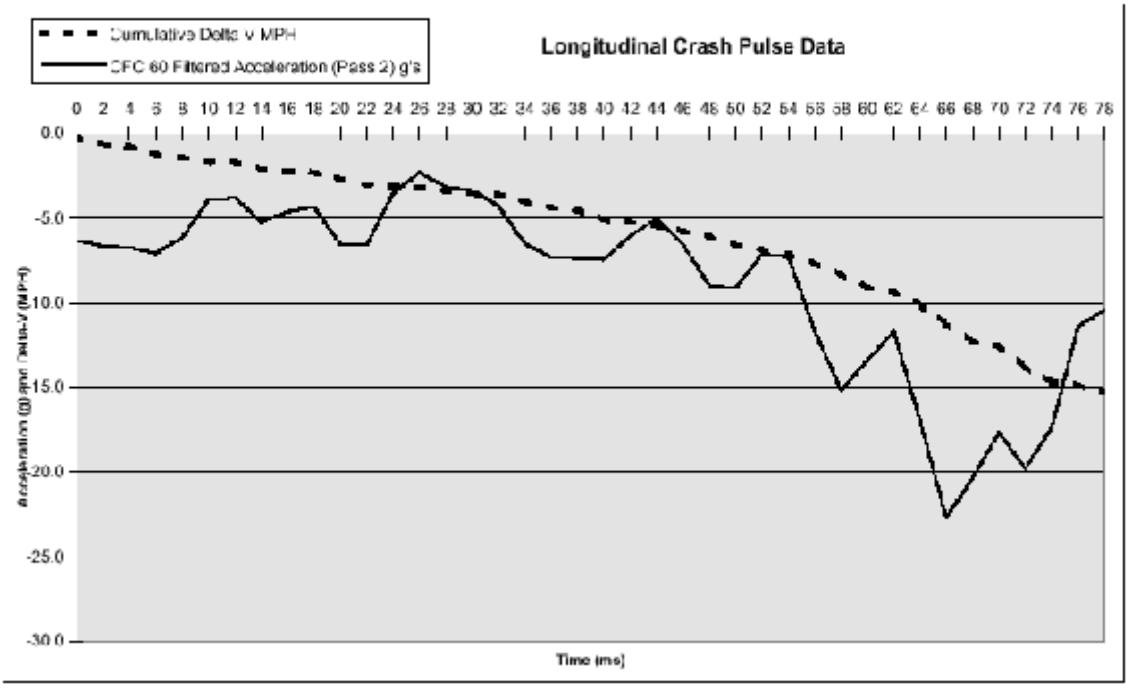
Restraint System Status

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:	15	Unbelted
Time From Algorithm Wakeup to First Stage Deployment Attempt:	25	25
Time From Algorithm Wakeup to Second Stage Deployment Attempt:	Disposal	Disposal

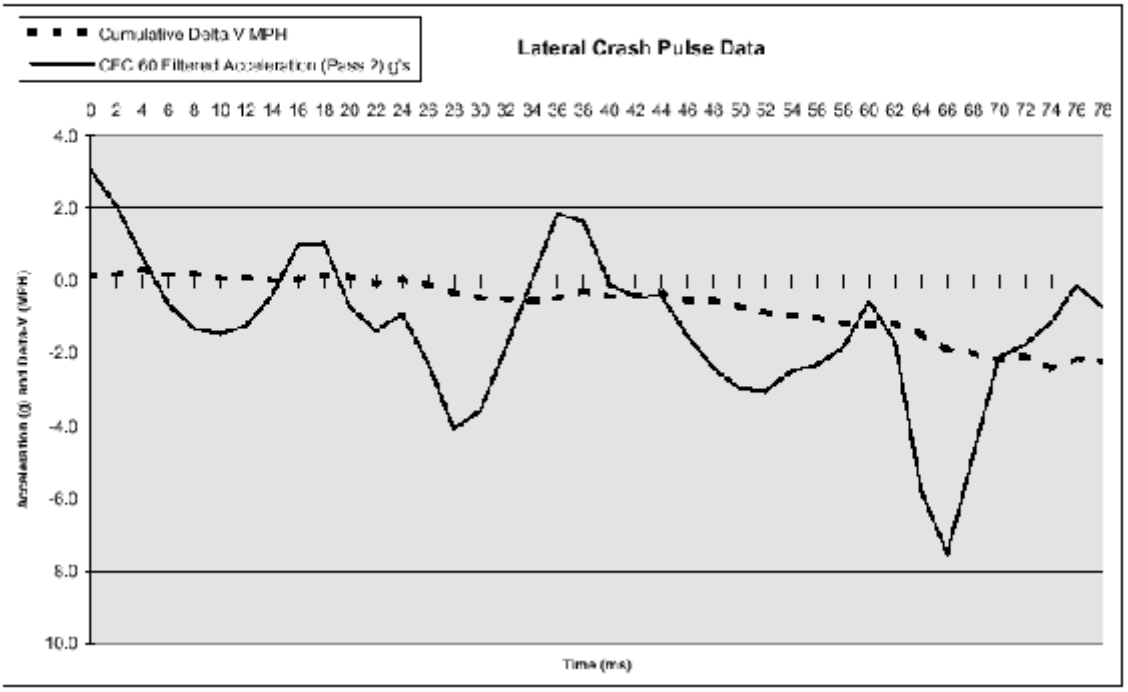
Longitudinal Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	-0.2	-1.7	-2.7	-3.6	-5.1	-5.6	-9.1	-12.6	-15.3



Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	78
Delta-V (MPH)	0.2	0.1	0.1	-0.5	-0.4	-0.1	-1.2	-2.2	-2.2



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	E3	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	64	64	00	0C	01
0840	5A	96	50	FF	FF	FF	EF	DF	D5	E7	FF	72	4E	13	25	B1
0850	EC	14	09	0F	01	FF	FF	88	7F	FF	CD	44	08	FF	FF	95
0860	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0870	05	39	E3	96	64	00	8F	FF	59	46	31	41	00	02	FF	16
0880	02	FE	80	16	FE	80	06	FF	7F	12	FE	80	30	FE	80	FF
0890	35	FF	80	38	FF	80	FF	FF	00	FF	FF	00	FF	FF	00	FF
08A0	44	00	44	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	23	01	D4	0F
08C0	FF	31	01	D4	23	34	01	D4	23	51	02	96	13	10	FF	FE
08D0	01	0E	0C	80	02	58	16	87	1F	BE	01	0A	00	8C	01	04
08E0	00	F0	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	CC	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	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0950	18	00	19	00	0F	00	00	07	00	00	01	0D	0A	3D	34	43
0960	08	0B	00	18	0F	15	05	00	00	00	00	19	27	0C	15	11
0970	00	00	85	90	A0	7F	B0	AE	9F	9F	7B	75	C7	93	62	62
0980	80	7E	BA	5C	65	E2	E2	B2	70	5A	AB	B6	56	95	AC	BA
0990	D0	C1	7E	90	94	C1	C7	B1	CA	C0	AD	B7	B6	B6	B9	95
09A0	8E	99	8D	96	94	A2	8C	98	9E	8E	91	9B	9F	94	9A	9D
09B0	8D	91	99	87	9A	95	92	91	88	95	93	88	82	7D	94	7D
09C0	6E	6E	95	67	78	99	89	86	81	84	79	81	78	80	7C	80
09D0	85	7C	78	83	79	75	78	7E	7C	82	89	77	80	83	75	7F
09E0	78	77	7C	7B	79	7D	81	71	6B	7C	75	85	6E	8C	7C	00
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