On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS01007
2001 Mercury Sable
Kansas
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 Advanced Occupant Protection System features. The collision occurred in Kansas in January, 2001 at 1703 hours. This was a two vehicle angle/broadside type collision at the intersection of a heavily congested entrance/exit to a strip mall and surface street. The case vehicle is a 2001 Mercury Sable that was driven by an unrestrained 20-year-old female. The 2nd seat left position was occupied by an unrestrained 3-year-old male child. The case vehicle was traveling eastbound in the left through lane. The other vehicle, a 1971 Plymouth Road Runner driven by a 16-year-old male, was exiting the driveway traveling north and attempting a left turn to head west. As the Plymouth was in the middle of the intersection, the front (01FDEW1) of the case vehicle struck the front left (10LFEW3) of the Plymouth. On impact, the front air bags in the case vehicle deployed. After impact, the case vehicle rotated slightly counterclockwise and the Plymouth rotated clockwise. There was a second impact with the right side (03RZEW2) of the case vehicle side-slapping the rear left (09LBEW2) of the Plymouth. Both vehicles were towed from the scene due to damage.

The police were notified of the collision at 1705 hours and arrived at the scene at 1710 hours. The local fire department EMS were notified and they arrived on scene treated and transported the injured to a local hospital where they were treated and released.

The driver of the case vehicle sustained an abrasion to her left palm and a right ankle fracture.

17. Key Words	18. Distribution Statement
Air bag, deployment, injury, accident, AOPS, advanced, rental, fleet, passenger,	

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: DS01007

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BACKGROUND:

Description:	This Advanced Occupant Protection System case was reported to the NHTSA by DSI on March 28, 2001 and the case was assigned to DSI on March 30, 2001. An on-site investigation was conducted and all field work was completed on April 4, 2001.
Investigation Type:	On scene
Crash Location:	Kansas
Crash Date:	January, 2001
Notification Date:	March 30, 2001
Field Work Completed:	April 4, 2001

SUMMARY:

The collision occurred in Kansas in January, 2001 at 1703 hours. This was a two vehicle angle/broadside type collision at the intersection of a heavily congested entrance/exit to a strip mall and surface street. The eastbound roadway consists of a right turn lane into the strip mall, two through travel lanes and a left turn lane. East and west traffic are separated by a raised concrete center median. The westbound roadway consists of two through travel lanes and a left turn lane. At the point of impact, the eastbound roadway surface is straight and level. There are no traffic controls and the speed limit for east and westbound traffic is 56 km/h (35 mph). The driveway consists of three lanes. Northbound traffic is exiting the strip mall and there is a left or through travel lane and right turn only lane. The third lane is entering the strip mall in a southerly direction. Northbound traffic is controlled by a standard stop sign and the speed limit is 40 km/h (25 mph). The weather was clear and the asphalt road surface was dry.

Figure 1. Direction of travel for case vehicle towards the impact area (east).

The case vehicle is a 2001 Mercury Sable that was driven by an unrestrained[1] 20-year-old female. This was a rental vehicle. The 2nd seat left position was occupied by an unrestrained 3-year-old male child. The case vehicle was traveling eastbound in the left through lane. The other vehicle, a 1971 Plymouth Road Runner driven by a 16-year-old male, was exiting the driveway traveling north and attempting a left turn to head west. As the Plymouth was in the middle of the intersection, the front (01FDEW1) of the case vehicle struck the front left (10LFEW3) of the Plymouth. On impact, the front air bags in the case vehicle deployed. The case vehicle sustained a total delta v of 18.2 km/h (11.3 mph), a longitudinal delta v of -15.8 km/h (-9.8 mph), and a latitudinal delta v of -9.1 km/h (-5.7 mph)[2]. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -24.9 km/h (-15.5 mph) and a cumulative lateral delta v of -14 km/h (-8.7 mph) at the 78 ms mark. The EDR report is included as an attachment to this report.

Figure 2. Front, case vehicle

The Plymouth sustained a delta v of 16.3 km/h (10.1 mph), a longitudinal delta v of -6.9 km/h (-4.3 mph), and a latitudinal delta v of 14.8 km/h (9.2 mph). The WinSmash results fit the collision model for both vehicles and appear reasonable for the case vehicle but borderline for the Plymouth.

Figure 3. Second impact-side slap to case vehicle.

[1] The police report indicates that she was restrained by the available lap and shoulder belt. Measurement of the pretensioner barrel indicates that it did not fire and therefore the lap and shoulder belt was not engaged.

[2]Calculated using the damage only algorithm of Winsmash 1.2.1 and stiffness values for the case vehicle calculated using NCAP crash data. CDC for Plymouth estimated from insurance photographs.

After impact, the case vehicle rotated slightly counterclockwise and the Plymouth rotated clockwise. There was a second impact with the right side (03RZEW2) of the case vehicle side-slapping the rear left (09LBEW2) of the Plymouth. The case vehicle sustained a latitudinal delta v of -11.5 km/h (-7.1 mph).

Figure 4. Exterior damage to Plymouth.

Both vehicles were towed from the scene due to damage.

The police were notified of the collision at 1705 hours and arrived at the scene at 1710 hours. The local fire department EMS were notified and they arrived on scene treated and transported the injured to a local hospital where they were treated and released.

The driver of the case vehicle sustained an abrasion to her left palm and a right ankle fracture.

The police report indicates that the driver and 3-year-old in the case vehicle sustained “possible injuries”. The police report further indicated that the driver was treated for a possible fractured right ankle. The 3-year-old was treated for minor back pain and released.

The driver of the Plymouth also sustained “possible injuries”. He was treated at the scene by EMS personnel and released without transporting.

Scene Diagram

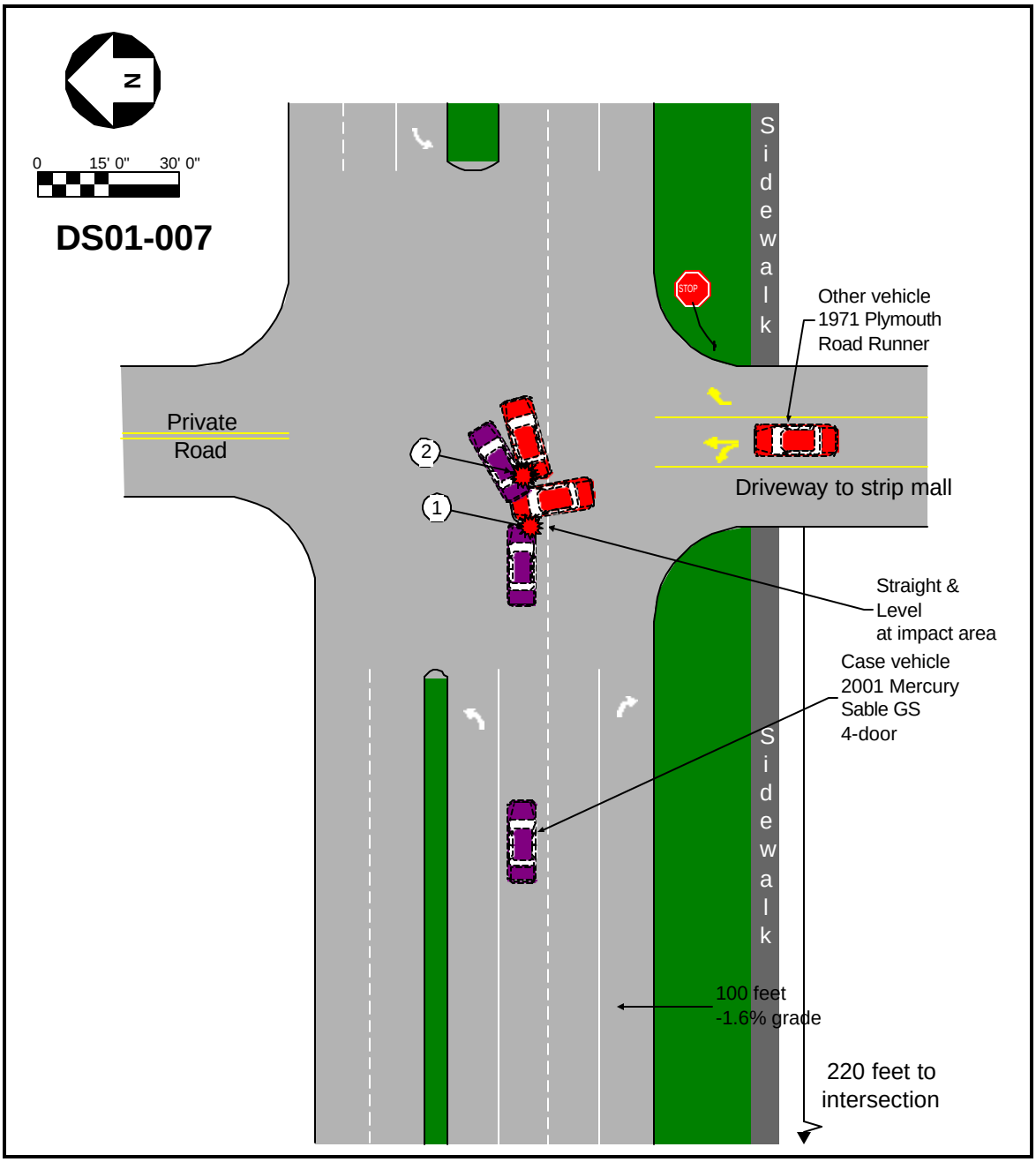


Figure 5. Scene diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2001 Mercury Sable four door sedan (rental)	
VIN:	1MEFM50U91Gxxxxxx	
Odometer:	2,242 km (1,393 miles)	
Engine:	3.0 L (182 CID), 6 cylinder	
Reported Defects:	None	
Cargo:	None	
Damage Description:	Moderate frontal damage to bumper, grille, and hood. Moderate side slap damage to right side above right tire and extending across right rear door.	
CDC:	Impact 1: 01FDEW1 Impact 2: 03RZEW2	
Delta V (Impact 1):	Total	18.2 km/h (11.3 mph)
	Longitudinal	-15.8 km/h (-9.8 mph)
	Latitudinal	-9.1 km/h (-5.7 mph)
	Energy	22,769 joules (16,791 ft-lbs)

Figure 6. Front right, case vehicle

AOPS Discussion

Figure 7. Front air bags

This vehicle was equipped with advanced occupant protection system features. 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 18.2 km/h (11.3 mph), a longitudinal delta v of -15.8 km/h (-9.8 mph) and a latitudinal delta v of -9.1 km/h (–5.7 mph) as computed by WinSmash. The downloaded Electronic Data Recorder (EDR) data indicates a cumulative longitudinal delta v of -24.9 (-15.5 mph) and a cumulative lateral delta v of -14 km/h (-8.7 mph) at the 78 ms mark.

The EDR report further indicates that:

1. This was a first stage deployment. The second stage was purged for disposal.
2. The driver's seat was not in the forward position.
3. The left front and right front seat buckles were not engaged.
4. The time from algorithm wake-up to pretensioner was 10 milliseconds
5. The time from algorithm wake-up to first stage - unbelted was 19 milliseconds.

Both front seat positions of the case vehicle were equipped with seat belt pretensioners. The pretensioner barrels were measured. The driver's pretensioner measured 11.1 cm (4.4 in.)-indicating that it had not fired. The passenger's pretensioner measured 11.0 cm (4.3 in.)-indicating that it had not fired. The right shear capsule stroke measured 0.9 cm (0.4 in.) and 0.4 cm (0.2 in.) to the left shear capsule. The steering column breakaway coupling was intact.

The case vehicle was equipped with a driver's and front right passenger's air bags. The driver's steering wheel mounted air bag was circular and measured 45 cm (17.7 in.) in diameter. It was equipped with two tethers and two vent holes. There was no evidence of driver contact although she possibly did contact the air bag. The dual module covers opened in a typical "H" configuration. There

were no indications of any damage to the covers. The front right passenger's top mounted air bag was rectangular and measured 61 cm (24.0 in.) by 48 cm (18.9 in.). It was equipped with two vent ports and did not have any tethers. On the face of the air bag there was cover-related scuffing. The single flap module cover did not sustain any damage.

Other vehicle

Description:	1971 Plymouth Road Runner	
VIN:	RM23N1Rxxxxxx	
Odometer:	139,210 km (86,504 miles)	
Engine:	383 CID V8	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Moderate lateral crush to left front fender and tire. Minor side slap damage to the left rear quarter panel.	
CDC:	Impact 1: 10LFEW3 Impact 2: 09LBEW2	
Delta V (Impact 1):	Total	16.3 km/h (10.1 mph)
	Longitudinal	-6.9 km/h (-4.3 mph)
	Latitudinal	14.8 km/h (9.2 mph)
	Energy	34,977 joules (25,824 ft-lbs)

Occupants

Case vehicle	Occupant 1	Occupant 2
Age/Sex:	20/Female	3/Male
Seated Position:	Front left	Second row, left
Seat Type:	Fabric covered bucket seat–seat track adjusted to the rear most position	Fabric covered bench seat
Height:	163 cm (64 in)	107 cm (42 in)
Weight:	74.8 kg (165 lbs)	14.9 kg (33 lbs)
Occupation:	Unknown	NA
Pre-existing Medical Condition:	None noted	None noted
Alcohol/Drug Involvement:	None	None
Driving Experience:	Unknown	NA
Body Posture:	Normal, upright	Normal, upright
Hand Position:	Both hands on steering wheel	Unknown
Foot Position:	Left foot on floor board, right on brake	Unknown
Restraint Usage:	Lap and shoulder belt available, not used	Lap and shoulder belt available, not used
Air bag:	Steering wheel mounted driver air bag deployed	NA

Other vehicle	Driver
Age/Sex:	16/Male
Seated Position:	Front left
Seat Type:	Leather covered bucket seat
Height:	Unknown
Weight:	Unknown
Occupation:	Unknown
Pre-existing Medical Condition:	None noted
Alcohol/Drug Involvement:	None
Driving Experience:	Minimal, likely less than 1 year
Body Posture:	Unknown
Hand Position:	Unknown
Foot Position:	Unknown
Restraint Usage:	Lap and shoulder belt used, per police report

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Abrasion, palm of right hand	790202.1,1	914.0	Air bag
	Fractured right ankle	852002.2,1	824.9	Floor board
Left rear occupant:	No coded injuries. Complained of back pain.			

Other vehicle

Driver:	No reported injuries.

Occupant Kinematics

The driver of the case vehicle was seated in a normal, upright fashion. She was not wearing the available lap and shoulder belt. The upper anchorage adjustment was in the up position. The fabric-covered bucket seat was adjusted to the rear most track position, and the seat back angle was adjusted to a rearward reclined position of 17E. Prior to impact, the driver began braking with her right foot. At impact, the unrestrained driver responded to the 1 o'clock direction of force by moving forward and to the right. Her face probably came into contact with the deploying air bag even though there was no evidence of contact. Both of her legs struck the left instrument panel causing damage to the rigid plastic cover and slight deformation to the left knee bolster. The deploying air bag contacted her right palm–causing a minor abrasion. Her right foot came off the brake to the right and contacted the floor board–causing an ankle fracture. She responded to the 3 o'clock side-slap by moving to the right and possibly struck the center arm rest/seat area.

The 3-year-old rear left occupant was seated in the 2nd seat left position and he was unrestrained. At impact, he responded to the 1 o'clock direction of force by moving forward and to the right. He probably struck the driver's seat back. He responded to the 3 o'clock side-slap by moving to the right.

Attachment 1. EDR readout

Investigation Data

File Name:	DS01-007.hex	File Save Date:	05-Apr-2001
File Read-out Date:	N/A	Report Date:	06-Apr-2001
Report Version:	1.5		

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:	10
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

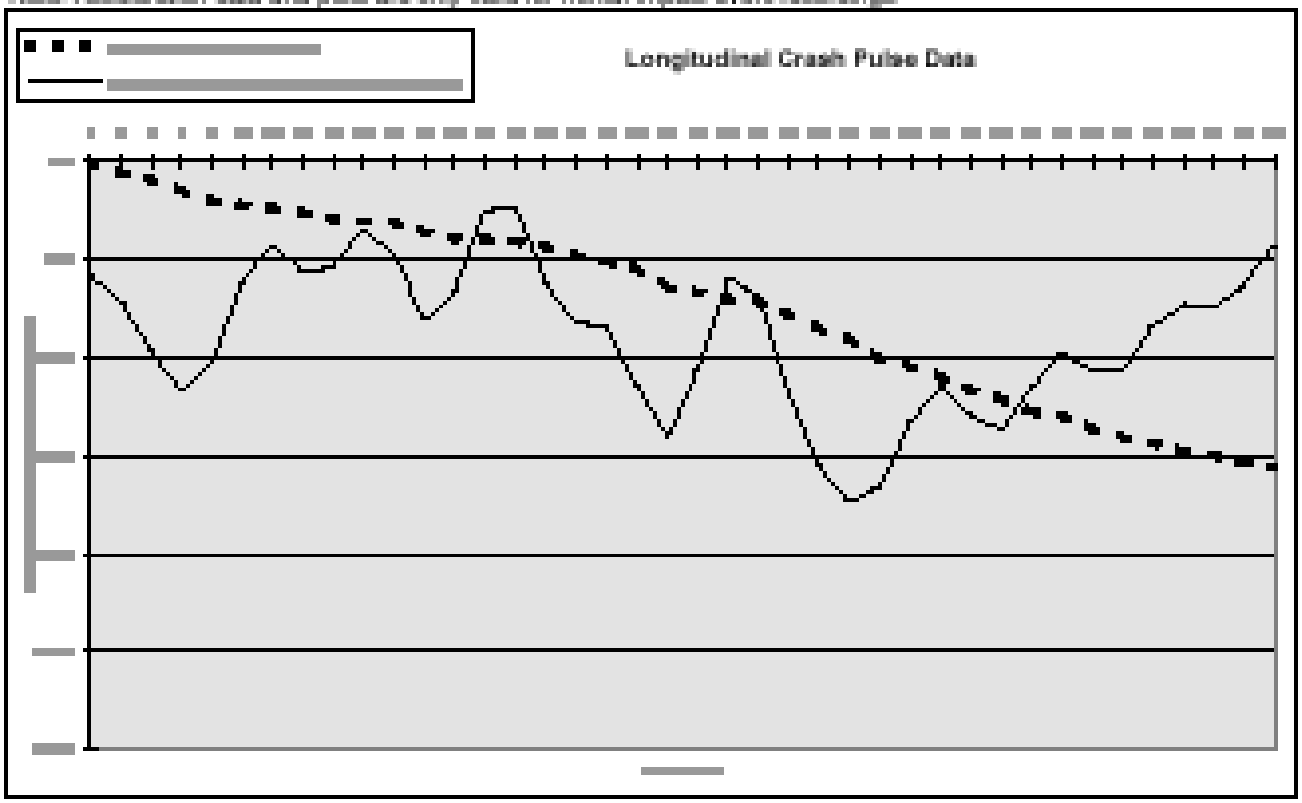
Driver Seat Belt Buckle:	Not Engaged
Passenger Seat Belt Buckle:	Not Engaged
Driver Seat Track In Forward Position:	No
Passenger Seat Weight Switch Position:	N/A

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)									

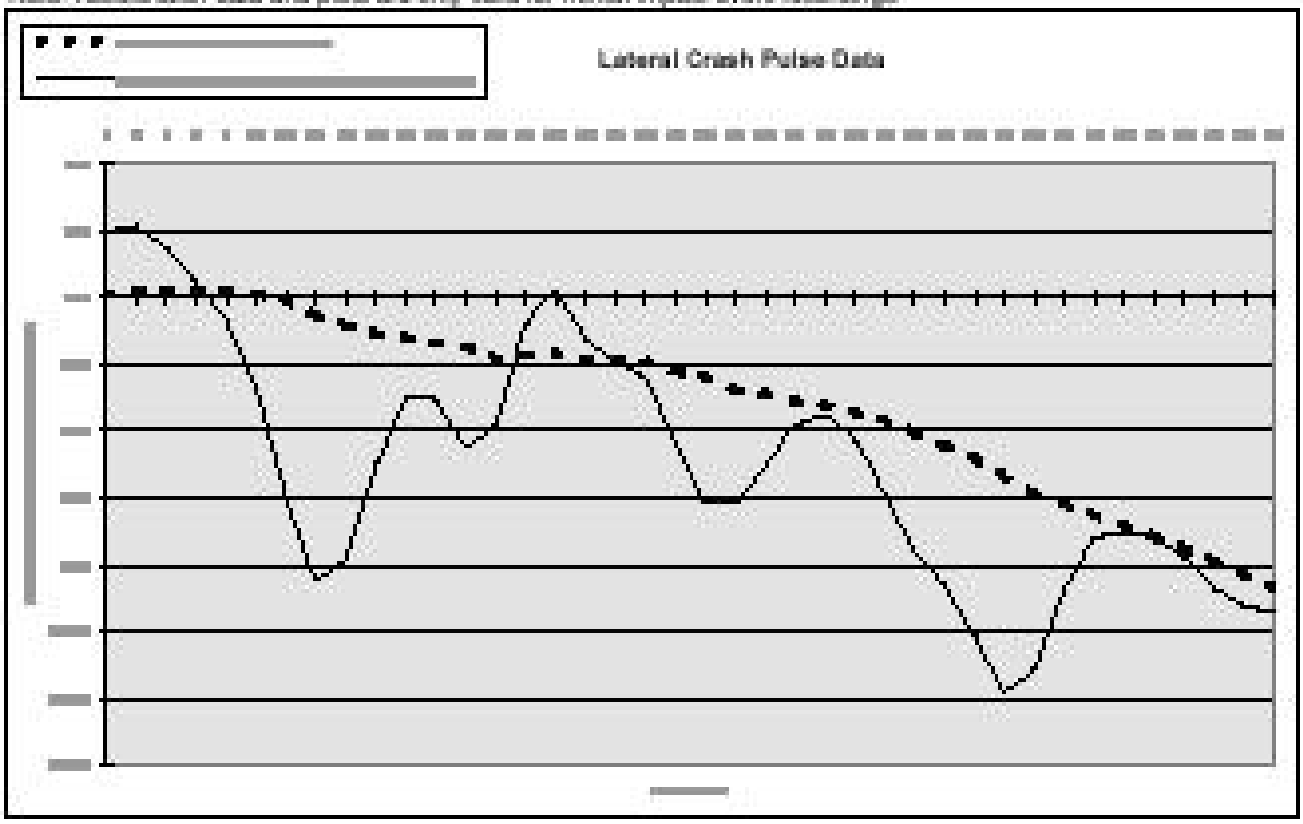
Note: Acceleration data and plots are only valid for frontal impact event recordings.



Lateral Cumulative Delta-V

Time (ms)	0	10	20	30	40	50	60	70	75
Delta-V (MPH)	---	---	---	---	---	---	---	---	---

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



File Name: DS01-007.hdr

Hexidecimal Module Memory Dump

Address	00	01	02	03	04	05	06	07	08	09	0A	0B	0C	0D	0E	0F
0800	11	4A	40	76	14	FB	FF	FF	FF	FF	CE	24	0F	2D	3A	57
0810	C8	FF	D0	FF	52	60	52	60	60	52	E0	20	3C	78	D6	A0
0820	C6	03	28	37	5F	0F	0F	0A	F5	CA	B7	84	A1	5E	C9	95
0830	03	DC	1E	1E	00	FF	3C	3C	90	C6	29	64	64	00	DC	01
0840	5A	96	50	FF	FF	FF	EF	DF	D5	E7	FF	73	4E	13	25	B1
0850	BC	14	09	0F	01	FF	FF	74	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	C6	1E	47	A8	E7	00	8F	FF	59	46	31	41	00	04	FF	19
0880	03	FC	80	12	FC	80	06	FF	7D	39	FF	80	09	FF	80	FF
0890	0A	FF	80	0F	FF	80	13	FF	80	FF	FF	00	FF	FF	00	FF
08A0	44	96	0C	00	00	00	00	01	00	00	FF	FF	FF	FF	FF	FF
08B0	03	FF	81	1E	00	8D	01	FF	FF	FF	FF	FF	26	01	ED	F9
08C0	FF	14	01	ED	F9	52	01	ED	F9	08	30	81	79	72	FF	FE
08D0	03	0E	0C	80	03	58	16	97	1F	BE	01	0A	00	8C	01	04
08E0	00	F0	01	16	00	A0	01	54	00	3F	02	30	01	C7	02	8A
08F0	05	14	07	08	01	2C	03	CA	04	CE	06	40	73	13	00	A0
0900	1F	FF	00	03	00	4B	01	CC	00	03	0F	FF	00	14	00	78
0910	00	A0	00	8E	0A	16	FF	01	00	00	00	7F	0F	0C	0F	02
0920	03	5A	12	46	05	50	02	02	FA	1E	09	0C	0A	1C	02	23
0930	09	08	28	12	16	20	16	1F	8F	FF	FF	03	FF	FF	FF	11
0940	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF	FF
0950	13	00	17	00	0A	00	00	07	00	00	04	0D	09	29	27	36
0960	08	0A	0C	12	0A	13	03	00	00	00	00	17	1F	1A	10	12
0970	00	00	93	10	A6	7D	AF	A5	99	9D	89	5D	A9	A6	99	61
0980	AE	94	7D	A5	D5	A6	92	C4	A3	A9	D0	B2	CC	BE	B7	B1
0990	9F	9F	A7	C1	B1	B1	B1	BA	AF	AE	A9	B6	A6	A1	B0	9B
09A0	97	95	8D	90	9C	9E	9C	95	A3	A1	9F	98	A6	9F	9D	9D
09B0	9B	96	7B	9B	9E	9D	9C	93	9E	77	94	90	B6	8F	B7	9E
09C0	8A	8F	9B	93	9B	95	9F	90	93	7F	7E	3C	77	74	6E	6F
09D0	73	78	75	7A	6B	83	7E	76	7A	7C	6F	7E	6E	78	72	78
09E0	73	73	6C	6C	6B	64	64	70	6D	6E	70	6D	6E	6B	6A	00
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