On-scene Investigation / Vehicle to Vehicle
Dynamic Science, Inc. / Case Number: DS01-008
2001 Chevrolet 1500 series 4x4 pickup
Arizona
March, 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.

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16. Abstract

The case vehicle was a 2001 Chevrolet 1500 series 4x4 pickup driven by an unrestrained 23-year-old female that was traveling eastbound at a speed of 80 km/h (50 mph). The case vehicle was equipped with a mechanical gas and brake hand control system. A 10-month-old female was seated on the driver's lap and was being breast fed at the time of the crash. An unrestrained 2-year-old male was seated in the front right seat position on the cloth covered bucket seat. The vehicle was equipped with dual front redesigned air bags. The other vehicle was a 1989 Ford F150 series pickup being driven by a 30-year-old male. The front right seat was occupied by an unknown age male. This vehicle was in the same lane and in front of the case vehicle. The driver of this vehicle had just driven out of a credit union parking lot. He had left his wallet on the roof of his vehicle. As the driver of the Ford pickup drove forward he saw his wallet fall off the roof. As the wallet fell off he braked suddenly. The driver of the case vehicle began braking. The driver was unable to stop in time and the front of the case vehicle struck and under-rode the rear of the Ford. Both frontal air bags in the case vehicle deployed during the impact. At impact, the deploying air bag struck the child and forced her into the driver. The child sustained fatal head/skull injuries. She was transported to a local trauma center and was pronounced dead at 0917 hours (17 minutes after the crash). The unrestrained driver sustained a variety of contusions and abrasions, but their exact locations are not known. The unrestrained front right occupant of the case vehicle pitched forward in response to the initial braking and then engaged the passenger air bag as it deployed. The case vehicle came to rest on the roadway several feet forward of the impact. It was towed from the scene due to damage and was subsequently placed under a police hold. The other vehicle was pushed forward and then there was an attempt to drive it from the scene. The front right passenger exited the vehicle and attempted to flee down a dry river bed. The other vehicle finally came to rest several hundred feet from the impact. It was towed from the scene due to damage and subsequently placed under a police hold. The driver of the other vehicle was later arrested for immigration violations and is currently in Federal prison.

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Dynamic Science, Inc.
Accident Investigation
Case Number: DS01-008

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BACKGROUND:

Description: This case was initiated in response to a report of a child air bag fatality. The case vehicle was equipped with mechanical hand controls. It was reported that the driver of the vehicle was a paraplegic; this, however, was not the case. The driver's husband is a paraplegic but was not part of this case. The vehicle was equipped with an Electronic Data Recorder (EDR). The NHTSA was notified of the incident via email that was based on a report from the local newspaper. DSI was notified on April 3, 2001. The case vehicle had been placed on a police hold for several months while the county attorney determined if charges were to be filed . DSI inspected the case vehicle on December 7, 2001. In attendance at the inspection was the county attorney, the investigating officer, and several police observers. All remaining field work was completed that day. Later that week it was determined that no charges were going to be filed.

Investigation Type: On-scene

Crash Location: Arizona
Crash Date: March, 2001
Notification Date: April 3, 2001
Field Work Completed: December 7, 2001

SUMMARY:

This two-vehicle crash occurred in Arizona in March, 2001 at 0848 hours. The crash took place on a straight two-lane, divided east/west roadway. The speed limit at this location is 56 km/h (35 mph).

The case vehicle was a 2001 Chevrolet 1500 series 4x4 pickup driven by a 23-year-old female that was traveling eastbound at a speed of 80 km/h (50 mph) as recorded by the EDR.

Figure 1. Area of impact–east

The case vehicle was equipped with a mechanical gas and brake hand control system (see Mechanical Hand Control discussion). The driver's husband is a paraplegic. The hand controls were not being used in this case. The driver was seated in an upright fashion on the cloth covered bucket seat. She was not using the integrated lap and shoulder belt. The driver's belt switch status showed that the seat belt was unbuckled at the time of the crash.

Figure 2. Front left, case vehicle

A 10-month-old female 71 cm/7.7 kg (28 in./17 lbs) was seated on the driver's lap and was being breast fed at the time of the crash. It appears that the child was on the driver's lap facing to the driver's left. This is mainly based on the abrasive surface injuries to the child's face and torso.

Figure 3. Left side, other vehicle

A 2-year-old male was seated in the front right seat position on the cloth covered bucket seat. He was not using the integrated lap and shoulder belt.

The vehicle was equipped with dual front air bags. The driver's air bag was circular and measured 48 cm (18.8 in). It was equipped with two tethers and two vents. The vents were located at the 11 and 1 o'clock positions on the back of the air bag. There was no damage to the air bag or the air bag module covers. The front right passenger's air bag was roughly rectangular and measured 54 x 90 cm (21.2 x 35.4 in). It was equipped with two vents and was not tethered. The vents are located at the 3 and 9 o'clock positions. There is a front right passenger air bag cut-off switch that was in the "ON" position at the time of the crash.

The other vehicle was a 1989 Ford F150[1] series pickup being driven by a 30-year-old male. The front right seat was occupied by an unknown age male. This vehicle was in the same lane and in front of the case vehicle. The driver of this vehicle had just driven out of a credit union parking lot. He had left his wallet on the roof of his vehicle. As the driver of the Ford pickup drove forward he saw his wallet fall off the roof. As the wallet fell off he braked suddenly.

[1]Model year and VIN on PAR are incorrect

The driver of the case vehicle saw the other vehicle brake. The throttle was not engaged at this time and the vehicle had decelerated to 77 km/h (48 mph). Two seconds before algorithm enable, the driver of the case vehicle began braking (the brake switch circuit status was ON). The case vehicle deposited 10.3 m (34 ft) of locked wheel skids. One second prior to algorithm enable, the EDR reported a vehicle speed of 72 km/h (45 mph). The driver was unable to stop in time and the front of the case vehicle (12FDMW2) struck and under-rode the rear of the Ford (06BDEW1). The case vehicle had a maximum crush of 58 cm (22.8 in) above bumper, 14 cm (5.5 in) at the bumper, and a maximum average crush of 33 cm (12.9 in). The case vehicle sustained a longitudinal delta v of -28.0 km/h (-17.4 mph) at the 120 ms mark as recorded by the EDR. WinSmash was run using averaged crush measurements for the case vehicle. The results were slightly lower for the case vehicle and should be considered borderline. According to the WinSmash run the case vehicle sustained a longitudinal delta v of -25.4 km/h (-15.8 mph)[2] and the other vehicle sustained a longitudinal delta v of 30.6 km/h (19.0 mph). Both frontal air bags in the case vehicle deployed during the impact.

At impact, the deploying air bag struck the child and forced her into the driver. There were no indications of any contact between the child and the air bag module cover. The child sustained the following injuries:

- diffuse subarachnoid hemorrhage, greater on the right
- severe cerebral edema with bilateral tonisllar herniation
- fractures of the right anterior, medial and posterior cranial fossa
- fractures of the right temporal bone
- fractures of the left occipital bone
- subgaleal hemorrhage over the right temporal bone
- hemorrhage into the right temporalis muscle
- hematoma and subgaleal hemorrhage over the left occipital bone
- laceration of the liver (5 cc blood within abdominal cavity)
- contusion and abrasion to right side of head 7 x 2 cm (2.8 x 0.8)
- abrasion/laceration directly below right eye 3 x 1 cm (1.1 x 0.4 in)
- contusion to right chest 3 x 1 cm (1.1 x 0.4 in)
- contusion/abrasion to right side of chin 3 x 1 cm (1.1 x 0.4 in)

She was transported to a local trauma center and was pronounced dead at 0917 hours (17 minutes after the crash).

It is reasonably clear that, since there was no contact to the module cover, all the injuries to the child came as a result of interaction between the air bag and the driver. This occupant died essentially due to a fractured skull due to forces from the deploying air bag and the driver's forward torso movement. She would likey have been injured to some degree whether or not the vehicle had been equipped with an air bag. However, the injuries would not have been as severe. The unrestrained driver's forward movement was being limited to some degree by the driver's left and right arms as she braced prior to

[2]The results are borderline. The case vehicle under-rode the other vehicle and the results are based on an averaged crush profile.

the crash. This was relatively soft crash as evidenced by the significant front end under-ride. It should also be noted that there were no indications of steering wheel deformation or loading. The majority of the injuries are air bag related. As the right side of the child's face was being struck by the deploying air bag the child's head was in contact with the driver, leaving no opportunity for significant rearward movement of the head.

The unrestrained driver sustained a variety of contusions and abrasions, but their exact locations are not known.

The unrestrained front right occupant of the case vehicle pitched forward in response to the initial braking and then engaged the passenger air bag as it deployed. There was no contact to the module cover or the instrument panel. According to the investigating officer, he sustained a number of contusions and abrasions but was not seriously injured.

The case vehicle came to rest on the roadway several feet forward of the impact. It was towed from the scene due to damage and was subsequently placed under a police hold.

The other vehicle was pushed forward and then there was an attempt to drive it from the scene. The front right passenger exited the vehicle and attempted to flee down a dry river bed. The other vehicle finally came to rest several hundred feet from the impact. It was towed from the scene due to damage and subsequently placed under a police hold. The driver of the other vehicle was later arrested for immigration violations and is currently in Federal prison.

Scene Diagram

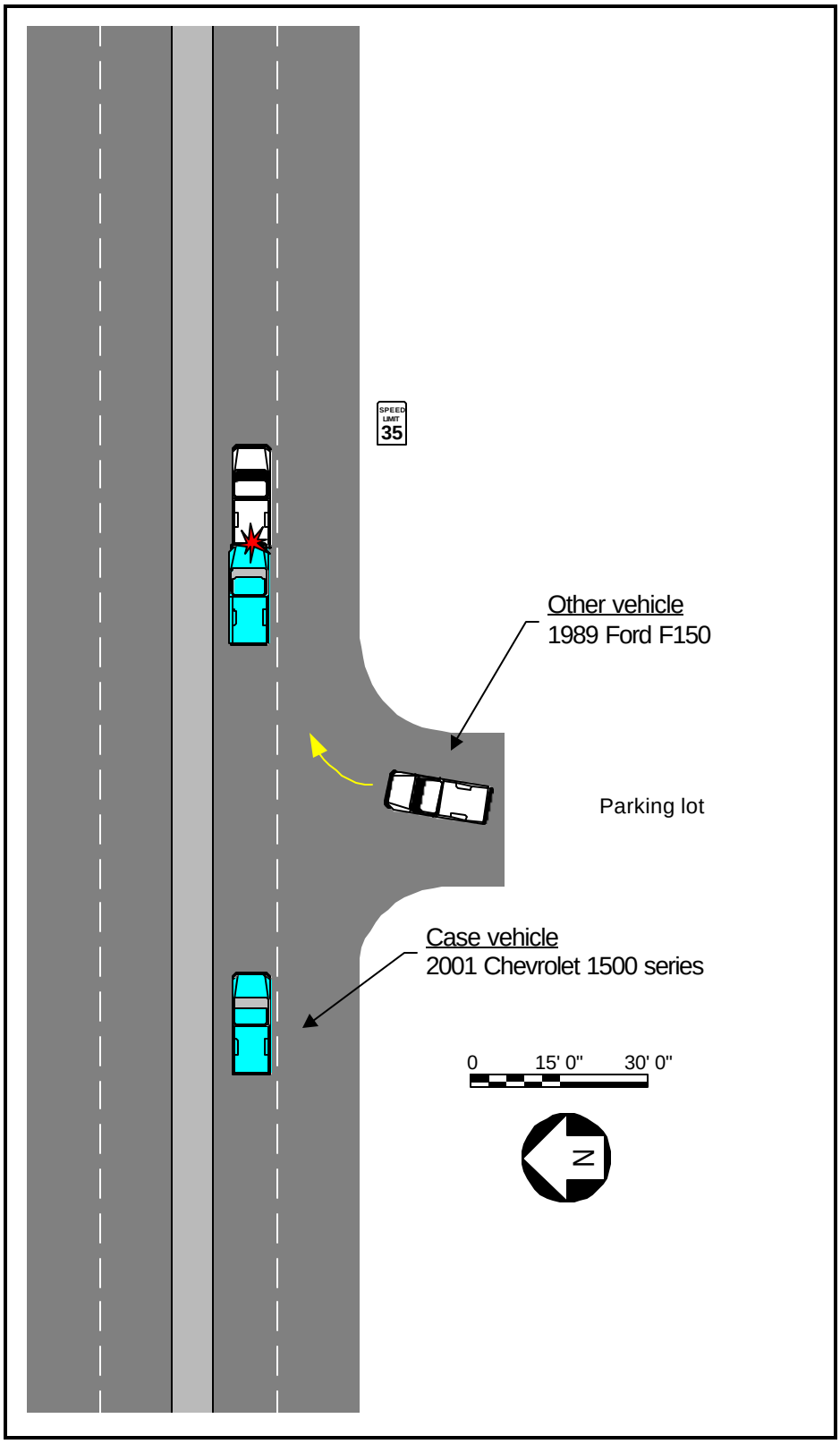

Figure 4. Scene diagram

DETAILED INFORMATION

Vehicles

Case vehicle

Description:	2001 Chevrolet 1500 series 4x4 pickup	
VIN:	2GCEK19T511xxxxxx	
Odometer:	Unknown	
Engine:	5.3l V8	
Reported Defects:	None	
Cargo:	Unknown	
Damage Description:	Moderate frontal crush. Above bumper crush to grille and hood.	
CDC:	12FDMW2	
Delta V[3]:	Total	25.4 km/h (15.8 mph)
	Longitudinal	-25.4 km/h (-15.8 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	87,671 joules (64,687 ft-lbs)

Figure 5. Front of vehicle

[3]Borderline WinSmash run

Mechanical Hand Control Discussion

The case vehicle was equipped with a Monarch Mark 1-A mechanical gas and brake hand control system. The brake is operated by pushing the operating handle towards the brake pedal; the accelerator is operated by moving the operating handle towards the driver's seat at a right angle to the brake movement. The brake and accelerator can be used separately or simultaneously. The hand control does require an automatic transmission, and must only be installed on vehicles with power steering and power brakes. The hand control system in this case was set up for left hand operation, but can be adjusted for right hand operation. It does not appear that the mechanical hand control factored into either the crash or injuries sustained during the crash.

Figure 6. Mark 1-A mechanical hand control

Figure 7. Mechanical hand control

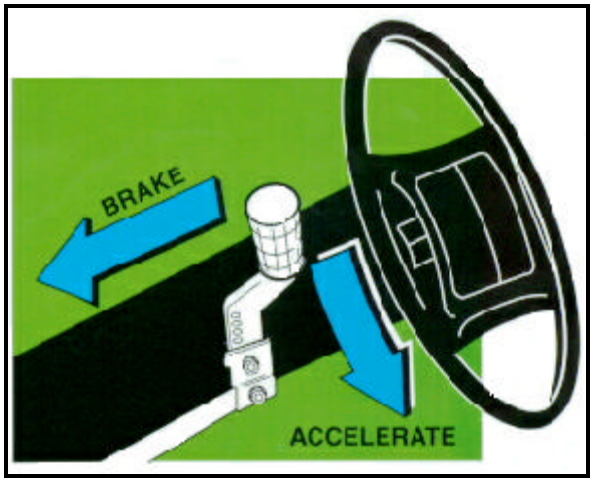

Figure 8. Hand control operation for Monarch Mark 1-A mechanical gas and brake hand control system

Other vehicle

Description:	1989 Ford F150 pickup 4 x 2	
VIN:	1FTEF15Y0KPxxxxxx	
Odometer:	Unknown	
Engine:	300 CID 6 cylinder	
Reported Defects:	None noted	
Cargo:	Unknown	
Damage Description:	Under-ride type damage to bumper area. Pickup bed forced into back of cab.	
CDC:	06BDEW1	
Delta V[4]:	Total	30.6 km/h (19.0 mph)
	Longitudinal	30.6 km/h (19.0 mph)
	Latitudinal	0 km/h (0 mph)
	Energy	40,057 joules (29,580 ft-lbs)

Figure 9. Right rear side, other vehicle

[4]Borderline WinSmash run

Occupants

Case vehicle	Occupant 1	Occupant 2	Occupant 3
Age/Sex:	23 year/Female	10 month/Female	2 year/Male
Seated Position:	Front left	Front left (in front of Occupant 1)	Front right
Seat Type:	Fabric covered bucket seat. Adjusted to between mid and rearmost track postion.	Fabric covered bucket seat. Adjusted to between mid and rearmost track postion.	Fabric covered bucket seat. Adjusted to between mid and rearmost track postion.
Height:	Unknown	71 cm (28 in.)[5]	Unknown
Weight:	Unknown	7.7 kg (17 lbs)	Unknown
Occupation:	Unknown	NA	NA
Pre-existing Medical Condition:	Paraplegia	None	None noted
Alcohol/Drug Involvement:	None	NA	NA
Driving Experience:	Unknown	NA	NA
Body Posture:	Based on the operation of the hand control, it would seem likely that the driver would be leaning forward to some degree to apply the brake.	Likely on driver's lap facing to the left of the vehicle.	Unknown
Hand Position:	Left hand on mechanical hand control	Unknown	Unknown
Foot Position:	Unknown	Unknown	Unkown

[5]Additional measurements: Head circumference (45.5 cm/17.9 in.), chest circumference (42 cm/16.5 in.), abdominal circumference (41 cm/16.1 in.), crown rump length (45 cm/17.7 in.).

Restraint Usage:	Integrated lap and shoulder belt, not used	Integrated lap and shoulder belt, not used. Seated in lap of Occupant 1.	Integrated lap and shoulder belt, not used
Air bag:	Steering wheel mounted air bag available, deployed	Steering wheel mounted air bag available, deployed	Mid instrument panel mounted air bag available, deployed

Other vehicle	Occupant 1	Occupant 2
Age/Sex:	30/Male	Unknown age/Male
Seated Position:	Front left	Front right
Seat Type:	Bench	Bench
Height:	Unknown	Unknown
Weight:	Unknown	Unknown
Occupation:	Unknown	Unknown
Pre-existing Medical Condition:	Unknown	Unknown
Alcohol/Drug Involvement:	None noted	NA
Driving Experience:	Unknown	NA
Body Posture:	Unknown	Unknown
Hand Position:	Unknown	Unknown
Foot Position:	Right foot presumed to be on brake, left on floorboard.	Unknown
Restraint Usage:	Unknown	Unknown

Injuries and Injury Mechanisms

Case vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Multiple contusions and abrasions	990400.1,9 990200.1,9	919.0 924.8	Unknown
LF Occupant (in lap of driver):	Diffuse subarachnoid hemorrhage, greater on the right	140684.3,	800.2[6]	Air bag
	Severe cerebral edema with bilateral tonisllar herniation	140660.3,	348.5	Air bag
	Fractures of the right anterior, medial and posterior cranial fossa	150402.2,1	800.20	Air bag
	Laceration of the liver (5 cc blood within abdominal cavity)	541820.2,1	864.2	Air bag
	Fractures of the left occipital bone	150402.2,2	800.20	Driver
	Fractures of the right temporal bone	150402.2,1	801.2	Air bag
	Contusion and abrasion to right side of head 7 x 2 cm (2.8 x 0.8)	190402.1,1 190202.1,1	910.0 920.0	Air bag
	Abrasion/laceration directly below right eye 3 x 1 cm (1.1 x 0.4 in)	290202.1,1 290600.1,1	910.0 873.40	Air bag
	Contusion to right chest 3 x 1 cm (1.1 x 0.4 in)	490402.1,1	922.0	Air bag
	Contusion/abrasion to right side of chin 3 x 1 cm (1.1 x 0.4 in)	290402.1,8 290202.1,8	910.0 920.0	Air bag

[6]Closed skull fracture

	Subgaleal hemorrhage over the right temporal bone	290402.1,1	920.0	Air bag
	Hematoma and subgaleal hemorrhage over the left occipital bone	290402.1,2	920.0	Air bag
	Hemorrhage into the right temporalis muscle	290402.1,1	920.0	Air bag
RF Occupant	Multiple contusions and abrasions	990400.1,9 990200.1,9	919.0 924.8	Unknown

Other vehicle

	INJURY	OIC CODE	ICD-9	SOURCE
Driver:	Injured, unknown severity			
RF Occupant	Injured, unknown severity			

Occupant Kinematics

The 23-year-old driver of the case vehicle was seated in an upright fashion in the fabric covered bucket seat. The seat was adjusted to between mid and rearmost track position. She was not using the available integrated lap and shoulder belt. The child was between the driver and the steering wheel. Given the need to support the child as she nursed, it seems likely that the child was facing to the driver's left with her back near the driver's right arm. Prior to impact, the driver released the throttle. Two seconds before algorithm enable, the driver engaged the brakes with her right foot. The braking motion moved the driver and the infant very close to the air bag module.

Figure 10. Driver's air bag

At impact, the driver and child occupant responded to the 0 degree direction of force by pitching forward. It is reasonably clear that since there was no contact to the module cover, all the injuries came as a result of interaction between the air bag and the driver. This occupant died essentially due to a fractured skull due to forces from the deploying air bag and the driver's forward torso movement. She would likey have been injured to some degree whether or not the vehicle had been equipped with an air bag. However, the injuries would not have been as severe. The unrestrained driver's forward movement was being limited to some degree by the driver's left and right arms as she braced prior to the crash. This was relatively soft crash as evidenced by the significant front end under-ride. It should also be noted that there were no indications of steering wheel deformation or loading. The majority of the injuries are air bag related. As the right side of the child's face was being struck by the deploying air bag the child's head was in contact with the driver, leaving no opportunity for significant rearward movement of the child's head.

Figure 11. Front right passenger air bag

The unrestrained front right occupant of the case vehicle pitched forward in response to the initial braking and then engaged the passenger air bag as it deployed. There was no contact to the module cover or the instrument panel. According to the investigating officer, he sustained a number of contusions and abrasions but was not seriously injured.

Attachment 1. Vetronix Report

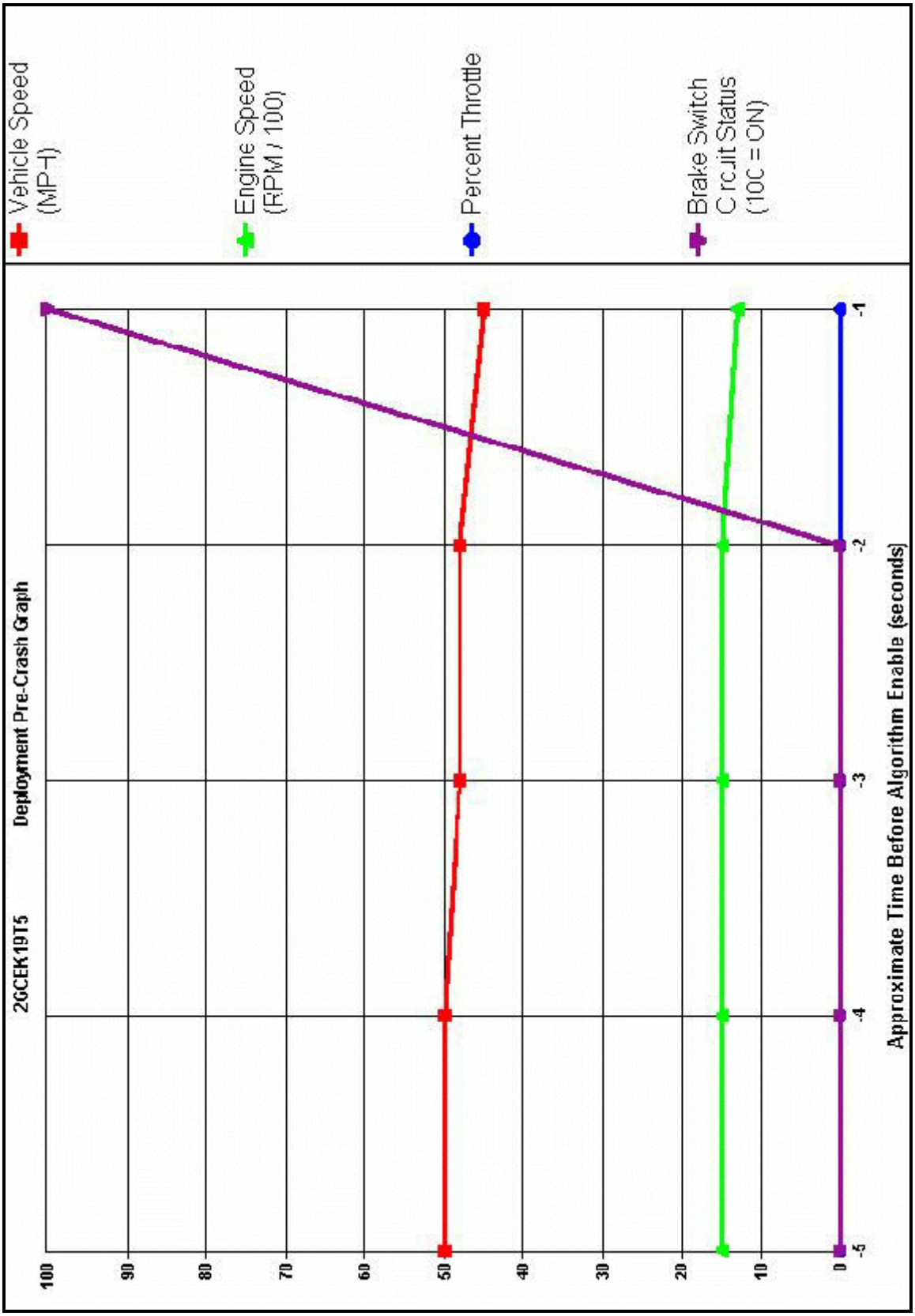

Figure 12. Pre-Crash Graph

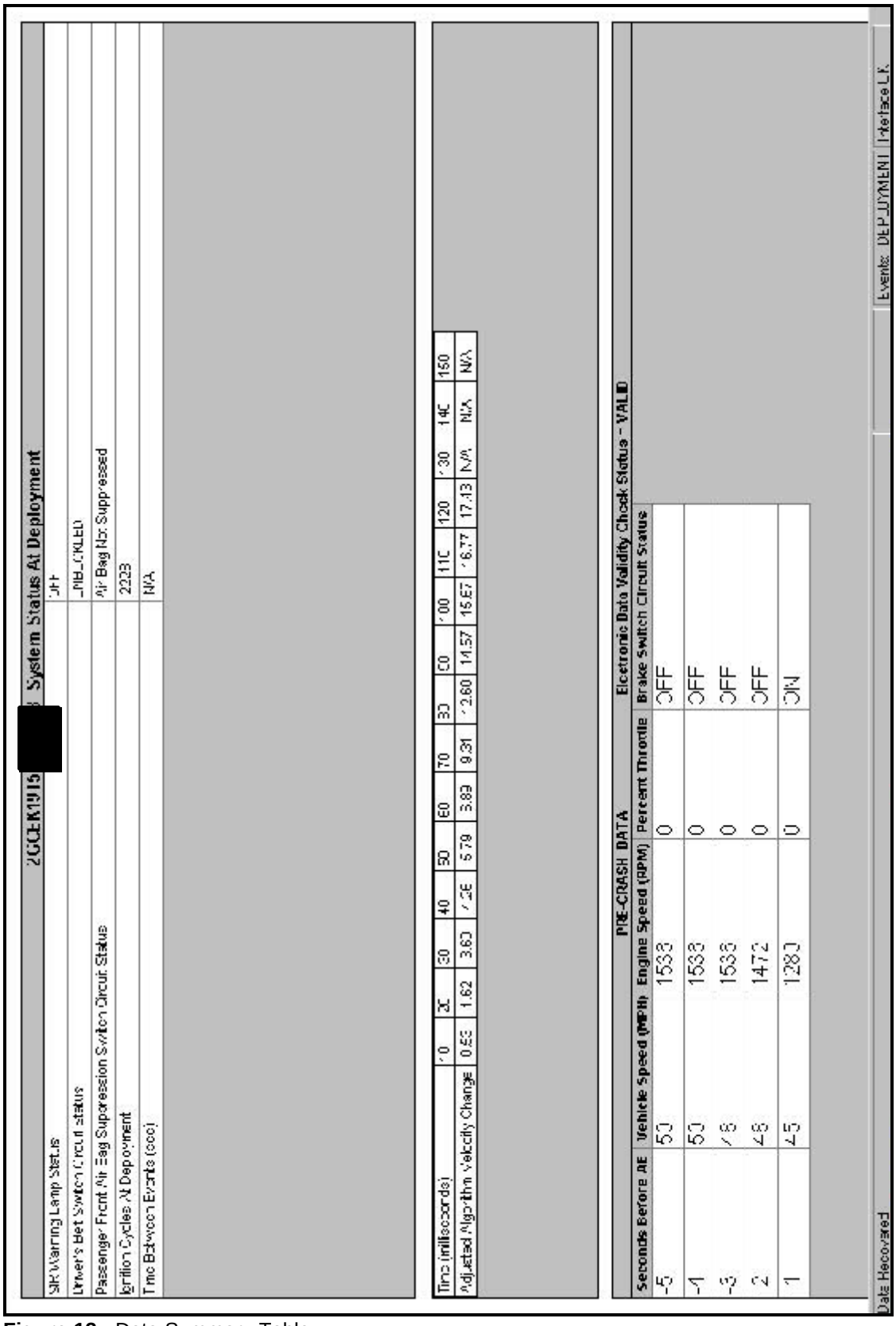

Figure 13. Data Summary Table

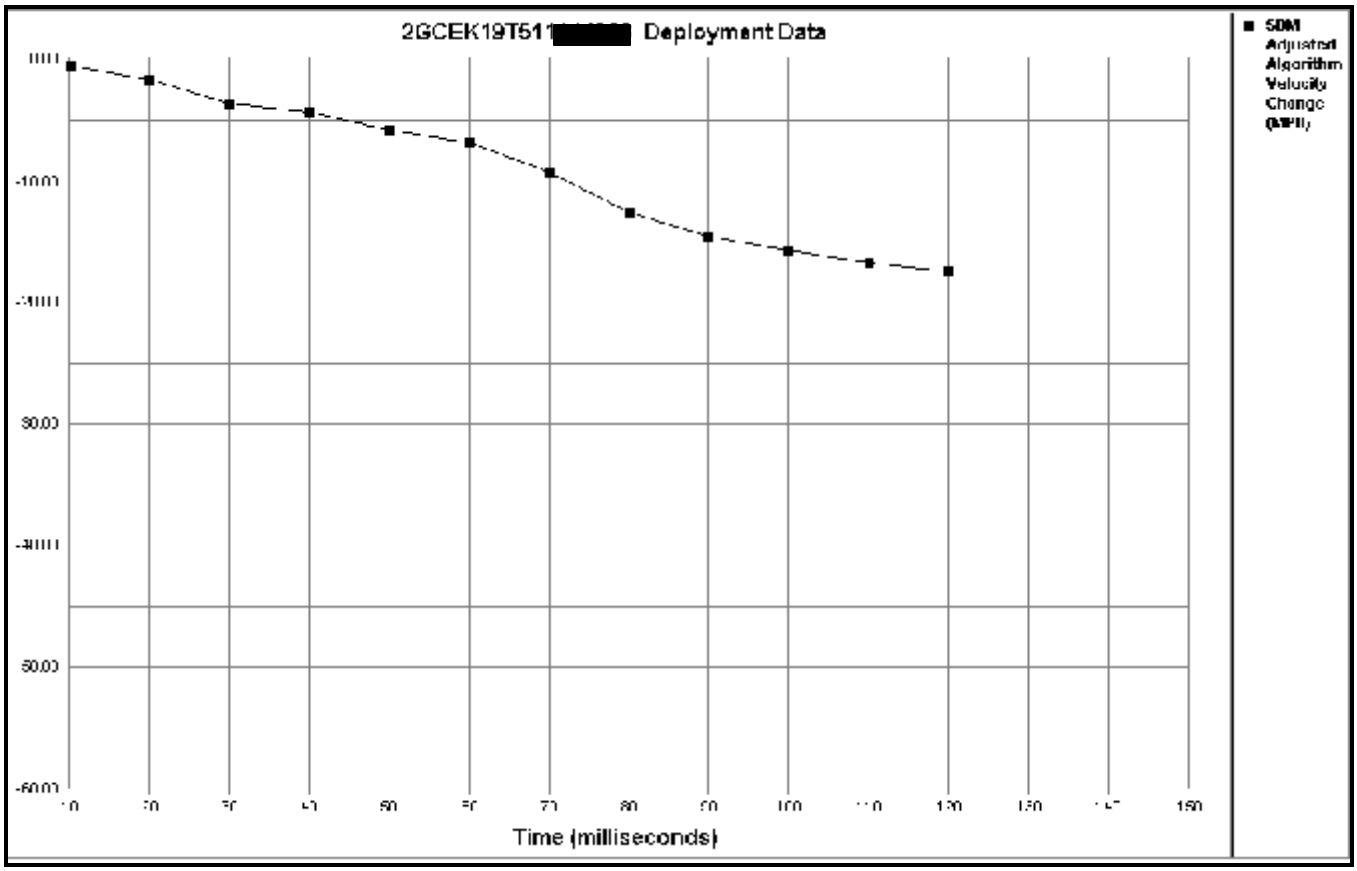

Figure 14. Post-Crash Graph: SDM Adjusted Algorithm Velocity Change