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SCI/NASS COMBINATION CASE REPORT

CASE NUMBER - NASS-2003-73-059A
LOCATION - Indiana
VEHICLE - 2001 CHEVROLET MONTE CARLO
CRASH DATE - April 2003

Submitted:

October 24, 2003

Contract Number: DTNH22-01-C-07002

Prepared for:

U.S. Department of Transportation
National Highway Traffic Safety Administration
National Center for Statistics and Analysis
Washington, D.C. 20590-0003

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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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15. *Supplementary Notes*
SCI/NASS combination investigation of a crash involving a 2001 Chevrolet Monte Carlo with multiple advanced occupant protection system features that ran off road, struck a pole and then rolled over

16. *Abstract*
This combination SCI/NASS investigation covers an air bag deployment crash involving a 2001 Chevrolet Monte Carlo (case vehicle) that ran off the road, impacted and sheared off a timber utility pole and then rolled over. This crash is of special interest because the case vehicle was equipped with multiple advanced occupant protection system (AOPS) features and an Event Data Recorder (EDR) that was successfully downloaded. The restrained case vehicle driver (63-year-old male) sustained fatal injuries. There was no other occupant in the case vehicle. The case vehicle was traveling west in the westbound lane of a two-lane local road and was entering a curve to the left. It was daylight, the weather was cloudy, the asphalt road surface was dry and with no apparent defects. The speed limit was 48 km.p.h. [30 m.p.h.]. A witness who was traveling west on the same roadway ahead of the case vehicle stated that she observed the case vehicle swerving back and forth in its lane. The case vehicle apparently continued straight ahead instead of negotiating the curve and departed the right (north) road edge. The case vehicle impacted a curve arrow sign and uprooted the sign post (event #1). The roadside descended into a steep downhill slope and the case vehicle began to tip to the right. The front center-left area of the case vehicle impacted a timber utility pole (event #2), causing the case vehicle's driver and front right passenger air bags to deploy, shearing the pole and causing the case vehicle to begin rotating counterclockwise. The steepness of the embankment's slope caused the case vehicle to roll to the right (event #3, NASS Rollover Type = Fall-Over), rolling two quarter-rolls as it tumbled down the embankment while rotating counterclockwise. The case vehicle came to rest on its roof at the base of the embankment, heading south. The driver sustained a cerebral hematoma/hemorrhage, a cerebral contusion, fracture of cervical vertebra C6, multiple rib fractures and various soft tissue injuries, resulting in his death.

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BACKGROUND

NASS-2003-73-059A

This SCI/NASS combination investigation was brought to the NHTSA's attention on April 25, 2003 by NASS/CDS sampling activities. This crash involved a 2001 Chevrolet Monte Carlo (case vehicle) that impacted a timber utility pole and rolled over. The crash occurred in April 2003, at 11:58 a.m., in Indiana, and was investigated by the applicable municipal police department. This crash is of special interest because the case vehicle was equipped with multiple advanced occupant protection system (AOPS) features and an Event Data Recorder (EDR) that was successfully downloaded. The restrained case vehicle driver (63-year-old male, white, non-Hispanic) sustained fatal injuries. There was no other occupant in the case vehicle. The NASS case data were received on July 29, 2003. This report is based on the NASS case coding, scene and vehicle photographs, the coroner's autopsy report and this contractor's evaluation of the evidence.

CRASH CIRCUMSTANCES

The case vehicle was traveling west in the westbound lane of a two-lane local road and was entering a curve to the left (**Figure 1**). It was daylight, the weather was cloudy, the asphalt road surface was dry and with no apparent defects. The speed limit was 48 km.p.h. [30 m.p.h.]. A witness who was traveling west on the same roadway ahead of the case vehicle stated that she observed the case vehicle swerving back and forth in its lane. The case vehicle apparently continued straight ahead instead of negotiating the curve and departed the right (north) road edge (**Figure 2**). The case vehicle impacted a curve arrow sign and uprooted the sign post (event #1). The roadside descended into a steep downhill slope and the case vehicle began to tip to the right. The front center-left area of the case vehicle impacted a timber utility pole, causing the case vehicle's driver and front right passenger air bags to deploy, shearing the pole (event #2) and causing the case vehicle to begin rotating counterclockwise. The steepness of the embankment's slope caused the case vehicle to roll to the right (event #3, NASS Rollover Type = Fall-Over), rolling two quarter-rolls as it tumbled down the embankment while rotating counterclockwise. The case vehicle came to rest on its roof at the base of the embankment, heading south (**Figure 3**).

Figure 1: Case vehicle's westbound approach

Figure 2: Case vehicle departs roadway; note, uprooted sign replaced in this photo

CASE VEHICLE

The case vehicle was a 2001 Chevrolet Monte Carlo front wheel drive, two-door, five-passenger coupe (VIN: 2G1WW12E419------), equipped with a 3.4 liter V6 engine and an automatic transmission with a console-mounted selector lever. Four-wheel anti-lock brakes and traction control were standard for this model. The vehicle was equipped with dual-stage air bags at the driver and front right seat positions. The front right passenger air bag was installed in the active instrument panel configuration. The vehicle's wheelbase was 281 centimeters [110.5 inches]. The case vehicle was towed due to disabling damage.

Figure 3: Sheared pole (foreground) and the case vehicle's area of final rest, on its roof at the bottom of the embankment

CASE VEHICLE DAMAGE

The case vehicle was wrapped in plastic sheeting with the front bumper, grille and hood missing at the time of the inspection (**Figures 4** and **5**). The location where the case vehicle impacted the curve arrow sign (event #1) could not be determined and the CDC is unknown. Based on damage to engine components, direct contact with the timber utility pole was determined to be in the left-center area of the front, centered at 28 centimeters [11.0 inches] inward from the front left bumper corner. Maximum crush from the pole impact was measured as 61 centimeters [24.0 inches] at C2, slightly left of the center. The wheelbase was shortened by 1 centimeter [0.4 inches] on both sides. The CDC for the pole impact (event #2) was determined to be **12-FYEN-3 (10)**. There was a deep downward indentation in the windshield header and the roof indicating that the sheared pole probably contacted the roof structures as the case vehicle passed over the pole's foundation. Because the pole was sheared, this impact is not eligible for the WinSMASH reconstruction program. Based on the measured crush profile, the barrier equivalent speed was calculated as 40 km.p.h. [24.8 m.p.h.].

Figure 4: Case vehicle's front and left side

Figure 5: Case vehicle's front and right side

There was direct contact from the rollover (event #3) along the entire length and height of the right side and across the entire width and length of the roof. The right fender was crushed

inward and there was heavy abrading along the upper right A-pillar, with lesser crushing on the right door and quarter panel. The windshield was extensively cracked and partially out of place, and the glazing in all four side windows and the backlight was shattered. There was no damage on the left side. The CDC for event #3 was determined to be **00-TYDO-3 (non-horizontal)**.

There were numerous intrusions, including: the windshield header downward across the entire width (14 centimeters [5.5 inches] on the right, 5 centimeters [2.0 inches] on the left); the entire roof downward (16 centimeters [6.3 inches] at the front right and approximately 5 centimeters [2.0 inches] at the back left); the backlight header downward across the entire width (7 centimeters [2.8 inches]); the right door and B-pillar laterally (12 centimeters [4.7 inches]); and others. The only evidence of occupant contact was blood smears on the headliner and sunvisor above the driver's seat area, where the driver was positioned as he was suspended, upside down, by the restraint system when the case vehicle came to at final rest (**Figure 6**).

Figure 6: Case vehicle's front seat row, showing separated windshield, header and roof intrusion, and blood where the driver was positioned at final rest (highlighted)

AUTOMATIC RESTRAINT SYSTEM

The driver's air bag was located in the steering wheel hub. The module cover flaps opened to the left and right. Each flap measured 7 centimeters [2.8 inches] horizontally and 9 centimeters [3.5 inches] vertically. There was no evidence of damage to the flaps or the adjacent structures. The driver's air bag was round with a diameter of 53 centimeters [20.9 inches]. There was no damage to the bag and no evidence of occupant contact (**Figure 7**).

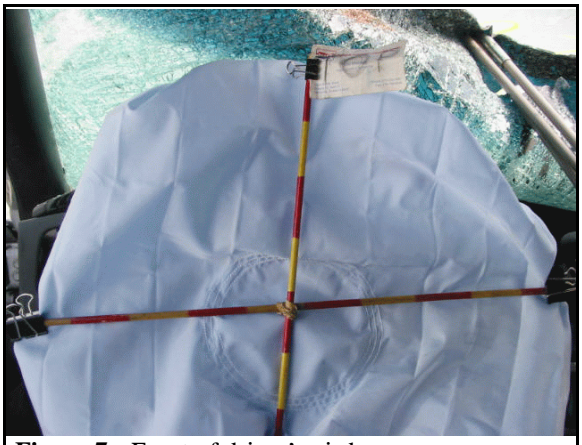


Figure 7: Front of driver's air bag

The front right passenger's air bag was located in the mid-mount position, on the front of the instrument panel, in a configuration that the manufacturer refers to as an "active instrument panel" (**Figure 8**). There are no module cover flaps as such. Rather, as the deploying air bag

Figure 8: Passenger's air bag, showing top of instrument panel raised by active instrument panel deployment (highlighted)

expands, it forces the top of the instrument panel upward, causing the points of attachment to break away and creating an opening between the horizontal top and the vertical front of the instrument panel. The air bag deploys through this opening. The deployed front right air bag was rectangular, measuring 55 centimeters [21.6 inches] horizontally and 40 centimeters [15.7 inches] vertically. There was no damage to the passenger's air bag and no contact evidence.

EVENT DATA RECORDER

The case vehicle's event data recorder was successfully downloaded. The Sensing and Diagnostic Module (SDM) reports are included at the end of this document. The EDR recorded a non-deployment event (**Figures 9 - 11**) associated with event #1 (the sign post impact), and a deployment event (**Figures 12 - 14**) associated with event #2 (the utility pole impact).

The two System Status Reports both show that the Supplemental Inflatable Restraint (SIR) warning lamp was OFF, indicating no error conditions in the automatic restraint system, the driver's safety belt was buckled and both the non-deployment and deployment events occurred during ignition cycle 2,956 (**Figures 9** and **12**). Both System Status Reports show that the case vehicle was traveling at 100 km.p.h. [62 m.p.h.] several seconds prior to the collision events, with throttle input and engine speed rising and travel speed increasing to 105 km.p.h. [65 m.p.h.] at one second prior to algorithm enable for the deployment event. The brake light circuit was never on at any time during the recorded pre-impact interval. The Deployment System Status Report (**Figure 9**) indicates that the deployment event occurred 0.6 seconds after the non-deployment event, which seems reasonable based on the scene geometry. Maximum longitudinal velocity change for the non-deployment event was recorded as -0.8 km.p.h. [-0.5 m.p.h.] at 95 milliseconds [0.095 seconds] after algorithm enable. For the deployment event, maximum longitudinal velocity change was -26.5 km.p.h. [-16.45 m.p.h.] at 107.5 milliseconds [0.1075 seconds] after algorithm enable. First stage deployment was commanded at 12.5 milliseconds [0.0125 seconds] after algorithm enable and the criteria for second stage deployment were not met. The Deployment Event Velocity Change Graph (**Figure 14**) shows delta V accumulating gradually, reflecting the "soft" nature of the impact as the case vehicle pushed against the pole and eventually fractured and sheared it. Velocity change recording ceased after 110 milliseconds [0.11 seconds].

CASE VEHICLE DRIVER KINEMATICS

The case vehicle driver (63-year-old male, white, non-Hispanic, 185 centimeters, 91 kilograms [73 inches, 201 pounds]) was restrained by the available, manual, three-point, lap-and-shoulder safety belt system. The police crash report indicated that "driver illness" was a contributing factor in this crash. There was no other occupant in the case vehicle and there is no knowledge of the driver's pre-crash posture. At the time of the inspection, the driver's seat was adjusted at the middle of the seat track, the seat back was slightly reclined and the tilt steering wheel was adjusted at the middle position.

The driver made no known pre-crash avoidance maneuvers and, based on the EDR pre-crash data, it appears that his foot was on the accelerator pedal as he drifted off the right side of the road. The impact with the sign post was very minor and probably had no effect on his posture,

but the roadside dropped off to a steep slope almost immediately and the driver probably began to pitch slightly forward and rightward as the vehicle's front right wheel started going down the slope. The front of the case vehicle impacted the timber utility pole, causing the driver and front right passenger air bags to deploy and shearing the pole. The driver moved forward and upward but was held essentially in place by the safety belt system. His face encountered the deployed air bag causing an abrasion on his forehead. His knees and lower legs impacted the knee bolster causing bilateral abrasions, and his left foot/ankle contacted the floor and/or foot controls, causing an abrasion. The case vehicle rolled two quarter-rolls to the right and came to rest on its roof at the bottom of the embankment. The driver moved upward with respect to the vehicle's interior as the roof intruded downward and the upper right area of his skull impacted the roof. He sustained a subgaleal hematoma on the upper right area of his scalp, a right cerebral contusion and a right cerebral hematoma/hemorrhage. He also sustained a fracture of the C6 vertebral body as the force of the impact was transmitted down his spinal column. His left arm flailed and impacted the windshield, causing a laceration on the posterior forearm. At final rest, he was suspended upside down by his safety belt, laying against the intruded roof.

CASE VEHICLE DRIVER INJURIES

The driver was declared dead at the scene and was transported directly to the morgue.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Cerebrum hematoma/hemorrhage, right	140629.4 severe	Roof	Probable	Autopsy
2.	Cerebrum contusion, right	140604.3 serious	Roof	Probable	Autopsy
3.	Fracture of C6 vertebral body, NFS	650230.2 moderate	Roof	Probable	Autopsy
4.	Multiple rib fractures, NFS	450210.2 moderate	Unknown	Unknown	Autopsy
5.	Right scalp subgaleal hematoma	190402.1 minor	Roof	Probable	Autopsy
6.	Forehead abrasion	290202.1 minor	Driver's air bag	Probable	Autopsy
7.	Bilateral knee and lower leg abrasions	890202.1 minor	Knee bolster	Certain	Autopsy
8.	Abrasion, left ankle	890202.1 minor	Floor	Certain	Autopsy
9.	Laceration, left posterior forearm	790602.1 minor	Windshield	Probable	Autopsy

2G1WW12E4192[redacted] System Status At Non-Deployment	
SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Non-Deployment	2956
Ignition Cycles At Investigation	2957
Maximum SDM Recorded Velocity Change (MPH)	-0.50
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	95
Event Recording Complete	Yes
Multiple Events Associated With This Record	No
One Or More Associated Events Not Recorded	No

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31	-0.31

PRE-CRASH DATA				
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	61	1536	15	OFF
-4	62	1600	15	OFF
-3	63	1664	20	OFF
-2	64	1664	26	OFF
-1	65	1664	31	OFF

Figure 9: Non-Deployment System Status Report

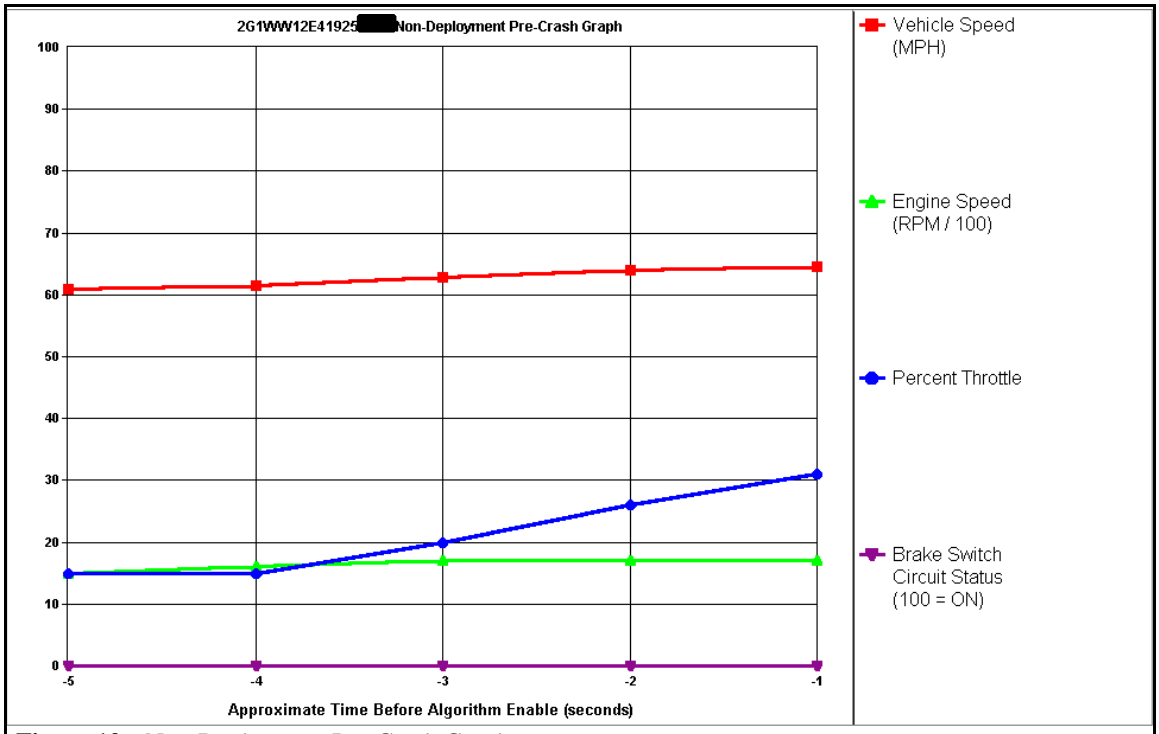


Figure 10: Non-Deployment Pre-Crash Graph

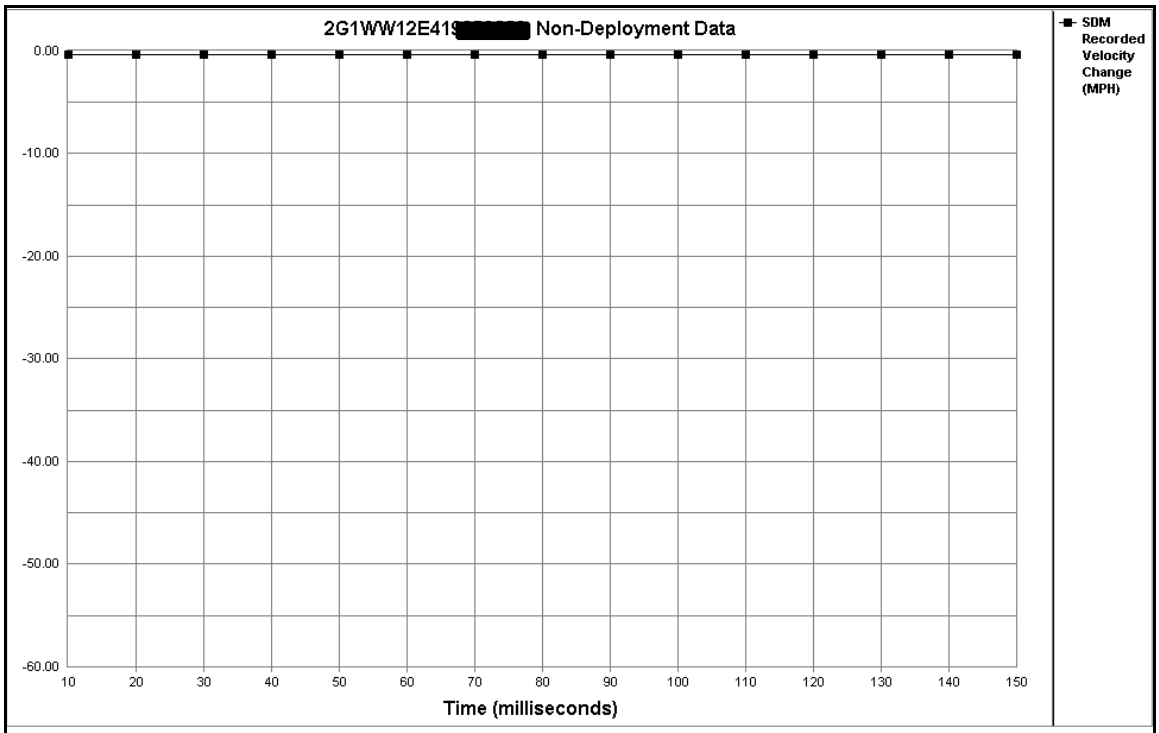


Figure 11: Non-Deployment Velocity Change Graph

2G1WW12E41[redacted]8 System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	2956
Ignition Cycles At Investigation	2957
Maximum SDM Recorded Velocity Change (MPH)	-16.45
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	107.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5
Driver Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Passenger First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	12.5
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Time Between Non-Deployment And Deployment Events (sec)	.6
Frontal Deployment Level Event Counter	2
Event Recording Complete	Yes
Multiple Events Associated With This Record	Yes
One Or More Associated Events Not Recorded	Yes

Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Recorded Velocity Change (MPH)	-1.24	-2.17	-3.72	-6.20	-9.30	-11.16	-12.71	-13.64	-14.57	-15.50	-16.43	N/A	N/A	N/A	N/A

PRE-CRASH DATA

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	62	1600	15	OFF
-4	63	1664	20	OFF
-3	64	1664	26	OFF
-2	65	1664	31	OFF
-1	65	2048	34	OFF

Figure 12: Deployment Event System Status Report

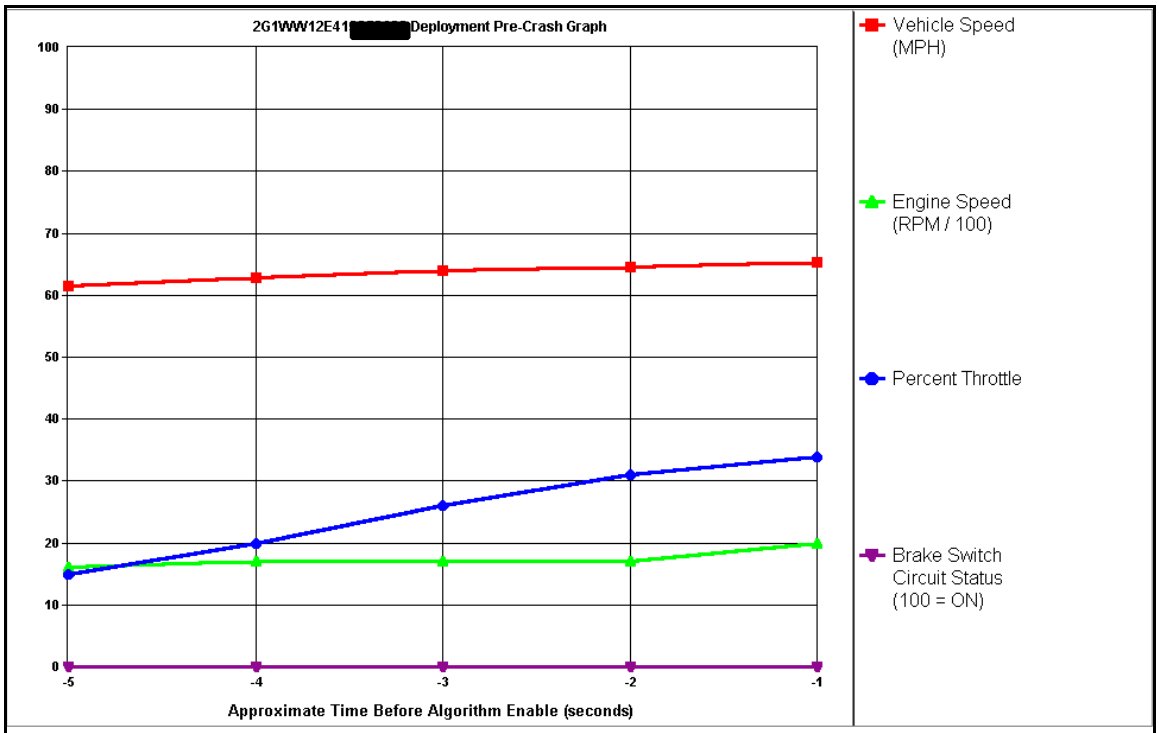
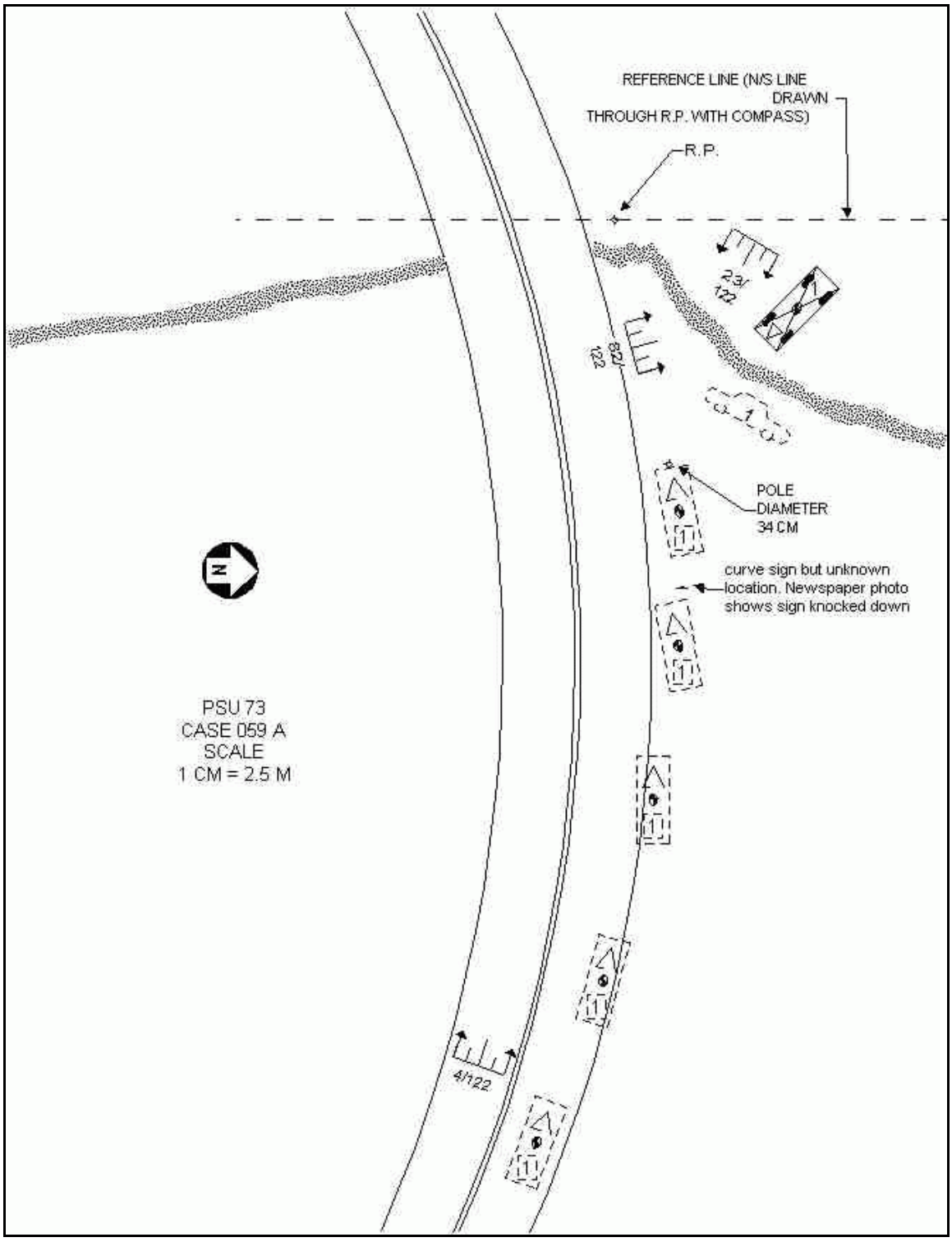


Figure 13: Deployment Event Pre-Crash Graph

Figure 14: Deployment Event Velocity Change Graph


REFERENCE LINE (N/S LINE DRAWN THROUGH R.P. WITH COMPASS)
R.P.
POLE DIAMETER 34 CM
curve sign but unknown location. Newspaper photo shows sign knocked down
PSU 73
CASE 059 A
SCALE
1 CM = 2.5 M
N
4/122