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ON-SITE AIR BAG INVESTIGATION

CASE NUMBER - IN-03-015
LOCATION - Wisconsin
VEHICLE - 2002 CHEVROLET MONTE CARLO
CRASH DATE - March 2003

Submitted:

June 26, 2003

revised:
October 8, 2003

Contract Number: DTNH22-01-C-07022

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

1. *Report No.* IN-03-015	2. *Government Accession No.*	3. *Recipient's Catalog No.*
4. *Title and Subtitle* On-Site Advanced Occupant Protection System Investigation Vehicle - 2002 Chevrolet Monte Carlo Location - Wisconsin		5. *Report Date:* June 26, 2003 6. *Performing Organization Code*
7. *Author(s)* Special Crash Investigations Team #2		8. *Performing Organization Report No.*
9. *Performing Organization Name and Address* Transportation Research Center Indiana University 222 West Second Street Bloomington, Indiana 47403-1501		10. *Work Unit No. (TRAIS)* 11. *Contract or Grant No.* DTNH22-01-C-07022
12. *Sponsoring Agency Name and Address* U.S. Department of Transportation (NRD-32) National Highway Traffic Safety Administration National Center for Statistics and Analysis Washington, D.C. 20590-0003		13. *Type of Report and Period Covered* Technical Report Crash Date: March 2003 14. *Sponsoring Agency Code*

15. *Supplementary Notes*
On-site investigation involving a 2002 Chevrolet Monte Carlo equipped with multiple advanced occupant protection systems that impacted a timber utility pole

16. *Abstract*

This on-site investigation concerns an air bag deployment crash involving a 2002 Monte Carlo LS (case vehicle) that impacted a timber utility pole. This crash is of special interest because the case vehicle was equipped with multiple advanced occupant protection system features as well as an Event Data Recorder (EDR) that was successfully downloaded. The case vehicle's driver (45-year-old female) sustained very minor injuries as a result of the crash. There was no other occupant. The case vehicle was traveling east in the eastbound lane of a two-lane, undivided county road. The asphalt road surface was covered with snow and ice and the case vehicle encountered a patch of ice, causing it to go out of control. The case vehicle driver reported that she released the accelerator, pumped the brakes and attempted to steer to regain control but the car slid off the road to the left, probably in a slight counterclockwise yaw, prior to the crash. The crash occurred off the roadway to the left (north). The front of the case vehicle impacted a timber utility pole, causing the case vehicle's driver and front right passenger air bags to deploy. The case vehicle was yawing with the right side leading and rotated a few degrees further counterclockwise. It was redirected by the pole impact and came to rest a short distance northeast of the pole, in a snow-covered farm field, heading north. The pole was not damaged. The case vehicle was towed due to disabling damage. The driver sustained a contusion on her left knee and did not seek medical treatment.

17. *Key Words* Air Bag Deployment Motor Vehicle Traffic Crash Injury Severity		18. *Distribution Statement* General Public	
19 *Security Classif. (of this report)* Unclassified	20. *Security Classif. (of this page)* Unclassified	21. *No. of Pages* 10	22. *Price* $5,200

Form DOT 1700.7 (8-72) Reproduction of completed page authorized

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BACKGROUND

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This on-site investigation was brought to NHTSA's attention on March 25, 2003 by GES sampling activities. This crash involved a 2002 Monte Carlo LS (case vehicle) that impacted a timber utility pole. The crash occurred in March 2003 at 6:50 a.m., in Wisconsin, and was investigated by the applicable county sheriff. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features as well as an Event Data Recorder (EDR) that was successfully downloaded. The case vehicle's driver (45-year-old female, white, non-Hispanic) sustained very minor injuries as a result of the crash. There was no other occupant. This contractor inspected the scene and vehicle and interviewed the driver on April 7, 2003. This report is based on the Police Crash Report, the interview with the case vehicle driver, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling east in the eastbound lane of a two-lane, undivided county roadway (i.e., there was one lane in each direction) and intended to continue straight ahead. The speed limit was 72 km.p.h. [45 m.p.h.], the asphalt road surface was covered with snow and ice, and the case vehicle encountered a patch of ice, causing it to go out of control. The case vehicle's driver reported that she released the accelerator, pumped the brakes and attempted to steer to regain control but the car slid off the road to the left, probably in a slight counterclockwise yaw, prior to the crash. The crash occurred off the roadway to the left (north).

The front of the case vehicle impacted a timber utility pole, causing the case vehicle's driver and front right passenger air bags to deploy. There was a slight drop off from the road edge and the case vehicle was probably in a slightly nose-down attitude at the moment of impact. The case vehicle was yawing with the right side leading and rotated a few degrees further counterclockwise. It was redirected by the pole impact and came to rest a short distance northeast of the pole, in a snow-covered farm field, heading north. The pole was not damaged. The ground was frozen and the pole's foundation was not disturbed.

The case vehicle was a 2002 Chevrolet Monte Carlo LS front wheel drive, two-door, five-passenger coupe (VIN: 2G1WW12E629------). The case vehicle was equipped with anti-lock brakes. Its wheelbase was 281 centimeters [110.5 inches]. The odometer reading is not known due to the non-functional electronic instrument panel. The driver estimated that the vehicle had been driven 28,967 kilometers [18,000 miles]. The case vehicle was equipped with dual-stage air bags at the driver and front right passenger seat positions. Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **01-FDEW-2 (40)**. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's impact. The Total, Longitudinal, and Lateral Delta Vs are, respectively: 20.0 km.p.h. [12.4 m.p.h.], -15.3 km.p.h. [-9.5 m.p.h.], and -12.9 km.p.h. [-8.0 m.p.h.]. The crash severity for the case vehicle was low (14 to 23 km.p.h. [9 to 14 m.p.h.]). The case vehicle was towed due to damage.

The case vehicle's contact with the utility pole involved the front bumper, grille, radiator, and hood. Direct damage was 54 centimeters [21.3 inches] wide and was located at the center of

the front. Maximum crush was measured as 38 centimeters [14.9 inches] at between C2 and C3. The wheelbase on the case vehicle's left side was shortened 2 centimeters [0.8 inches] while the right side remained unchanged. The front bumper, bumper fascia, grille, hood, and radiator were directly damaged and crushed rearward. The right and left fenders sustained induced damage. None of the case vehicle's tires were restricted or damaged and there was no glazing damage.

The case vehicle's driver air bag was located in the steering wheel hub. An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with four tethers, each 7.7 centimeters [3.0 inches] wide. The driver's air bag had two vent ports, approximately 3.5 centimeters [1.4 inches] in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 65 centimeters [25.6 inches]. There were routine deployment marks but no contact evidence readily apparent on the 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". There was no module cover flap as such. Rather, as the deploying air bag 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 with a height of approximately 54 centimeters [21.3 inches] and a width of approximately 36 centimeters [14.2 inches]. The air bag was designed with one tether, which was 32 centimeters [12.6 inches] wide. The front right air bag had two vent ports, approximately 4.5 centimeters [1.8 inches] in diameter, located at the 9:30 and 2:30 clock positions. There was no contact evidence on the front right air bag. Inspection of the case vehicle's interior revealed no other evidence of occupant contact on the interior surfaces of the vehicle.

The case vehicle's Event Data Recorder (EDR) was successfully downloaded in the field via the diagnostic port (i.e., the vehicle's electrical system was functional). The System Status Report shows that the Supplemental Inflatable Restraint (SIR) warning lamp was OFF indicating no error conditions in the automatic restraint system, the driver's seat belt was buckled and the deployment event occurred during ignition cycle 2,626. The case vehicle was traveling approximately 89 km.p.h. [55 m.p.h.] with 3 percent throttle five seconds prior to the impact. The driver pumped the brakes on, off and on again over the next four seconds and the vehicle slowed to 31 km.p.h. [19 m.p.h.] at one second prior to the impact. The case vehicle driver and front right passenger air bags were equipped with multi-stage inflators. The Sensing Diagnostic Module (SDM) report indicates that the command for first stage deployment was issued at 45 milliseconds [0.045 seconds] after algorithm enable and the criteria for second stage deployment were not met. The SDM report indicates that the maximum recorded longitudinal velocity change was -8.6 km.p.h. [-5.35 m.p.h.] at 107.5 milliseconds [0.1075 seconds] after algorithm enable. The velocity change data show deltaV accumulating gradually to the maximum at approximately 110 milliseconds following algorithm enable. Recording stopped at 140 milliseconds. The WinSMASH barrier algorithm calculated longitudinal deltaV for the case vehicle was -15.3 km.p.h. [-9.5 m.p.h.].

Immediately prior to the crash the case vehicle's driver (45-year-old female, white, non-Hispanic, 168 centimeters, 95 kilograms [66 inches, 210 pounds]) was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the foot controls, and both hands on the steering wheel. Her seat track was located between its middle and rear-most positions, the seat back was sightly reclined, and the tilt steering wheel was adjusted at its middle position. She was restrained by her available, active, three-point, lap-and-shoulder safety belt system. There was moderate stretching of the belt webbing and the EDR download indicated that the driver's safety belt buckle was fastened.

The case vehicle encountered a patch of ice and went out of control. The driver reported that, in an effort to avoid crashing the vehicle, she released the accelerator, pumped the brakes and tried to steer the vehicle back into control. Her posture probably did not change as a result of these attempted avoidance actions. The vehicle ran off the road to the left and the front tilted down as it traversed the drop off at the edge of the road. The case vehicle's impact with the utility pole caused the driver to move forward and slightly rightward and upward, toward the 1 o'clock direction of force. The safety belt retractor locked, holding her in place, and she encountered the deployed driver's air bag with her face and chest. Because she was restrained by the safety belt, she did not load heavily into the air bag. Because she was cushioned by the air bag, she did not load heavily against the safety belt webbing. Her left leg flailed and impacted the knee bolster. She rebounded into her seat as the vehicle came to rest.

According to her interview, the driver sustained a large bruise in the area of her left knee and no other injuries, and she did not seek any medical treatment.

CRASH CIRCUMSTANCES

Figure 1: Case vehicle's eastbound approach toward left side departure and impact with pole (case photo #02)

The case vehicle was traveling east in the eastbound lane of a two-lane, undivided county roadway (i.e., there was one lane in each direction) and intended to continue straight ahead. The speed limit was 72 km.p.h. [45 m.p.h.], the roadway was straight and level and the asphalt road surface was in good repair. The opposing lanes were separated by a solid yellow line for eastbound traffic and a broken yellow line for westbound. The paved surface was 7.6 meters [25 feet] wide, with narrow gravel shoulders and a shallow drainage ditch on each side. The roadway was covered with snow and ice and the case vehicle encountered a patch of ice, causing it to go out of control. The case vehicle's driver reported that she released the accelerator, pumped the brakes and attempted to steer to regain control but the car ran off the road to the left, probably in a slight counterclockwise yaw, prior to the crash. The crash occurred off the roadway to the left (north) (**Figure 1**).

The front of the case vehicle impacted a timber utility pole, causing the case vehicle's driver and front right passenger air bags to deploy. There was a slight drop off from the road edge and the case vehicle was in a slightly nose-down attitude at the moment of impact. The case vehicle was yawing with the right side leading and rotated a few degrees further counterclockwise. It was redirected by the pole impact and came to rest a short distance northeast of the pole,in a snow-covered farm field. The pole was not damaged. The ground was frozen and the pole's foundation was not disturbed. There was no visible evidence at the time of the scene inspection because the ground was covered with fresh snow since the date of the crash.

CASE VEHICLE

The case vehicle was a 2002 Chevrolet Monte Carlo LS front wheel drive, two-door, five-passenger coupe (VIN: 2G1WW12E629------). The case vehicle was equipped with anti-lock brakes. Its wheelbase was 281 centimeters [110.5 inches]. The odometer reading is not known due to the non-functional electronic instrument panel. The driver estimated that the vehicle had been driven 28,967 kilometers [18,000 miles]. The case vehicle was equipped with dual-stage air bags at the driver and front right passenger seat positions. The front right passenger's air bag was installed in the active instrument panel configuration.

CASE VEHICLE DAMAGE

The case vehicle's contact with the utility pole involved the front bumper, grille, radiator, and hood (**Figures 2** and **3**). Direct damage began 36 centimeters [14.2 inches] inward from the front right bumper corner (actual metal bumper, not bumper fascia) and extended 54 centimeters [21.3 inches] inward, along the front bumper. Maximum crush was measured as 38 centimeters [14.9 inches] between C2 and C3. The wheelbase on the case vehicle's left side was shortened 2 centimeters [0.8 inches] while the right side remained unchanged. The front bumper, bumper fascia, grille, hood, and radiator were directly damaged and crushed rearward. The right and left fenders sustained induced damage. None of the case vehicle's tires were restricted or damaged and there was no glazing damage.

Figure 2: Front of case vehicle, straight on (case photo #07)

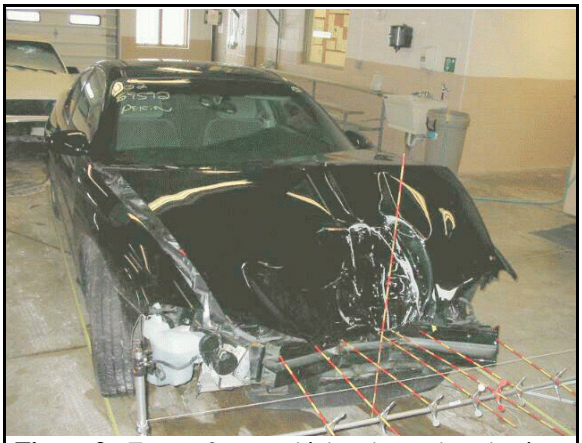


Figure 3: Front of case vehicle, elevated angle view from right (case photo #20)

Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **01-FDEW-2 (40)**. The WinSMASH reconstruction program, barrier algorithm, was used on the case vehicle's impact. The Total, Longitudinal, and

Lateral Delta Vs are, respectively: 20.0 km.p.h. [12.4 m.p.h.], -15.3 km.p.h. [-9.5 m.p.h.], and -12.9 km.p.h. [-8.0 m.p.h.]. The crash severity for the case vehicle was low (14 to 23 km.p.h. [9 to 14 m.p.h.]). The case vehicle was towed due to disabling damage.

AUTOMATIC RESTRAINT SYSTEM

The case vehicle's driver air bag was located in the steering wheel hub (**Figure 4**). An inspection of the air bag module's cover flaps and air bag revealed that the cover flaps opened at the designated tear points, and there was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed with four tethers, each 7.7 centimeters [3.0 inches] wide. The driver's air bag had two vent ports, approximately 3.5 centimeters [1.4 inches] in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 65 centimeters [25.6 inches]. There were routine deployment marks but no contact evidence readily apparent on the driver's air bag.

Figure 4: Front of driver air bag (case photo #34)

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". There was no module cover flap as such. Rather, as the deploying air bag 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 (**Figures 5** and **6**). The deployed front right air bag was rectangular with a height of approximately 54 centimeters [21.3 inches] and a width of approximately 36 centimeters [14.2 inches] (**Figure 7**). The air bag was designed with one tether, which was 32 centimeters [12.6 inches] wide. The front right air bag had two vent ports, approximately 4.5 centimeters [1.8 inches] in diameter, located at the 9:30 and 2:30 clock positions. There was no contact evidence on the front right air bag.

Figure 5: Raised top of active instrument panel, showing the opening through which the front right air bag deployed (case photo #41)

Figure 6: Active instrument panel raised across entire width (case photo #32)

Figure 7: Front of deployed front right air bag (case photo #37)

The case vehicle's Event Data Recorder (EDR) was successfully downloaded in the field via the diagnostic port (i.e., the vehicle's electrical system was functional). The Sensing Diagnostic Module (SDM) report is included as **Figures 8, 9** and **10**. The System Status Report shows that the Supplemental Inflatable Restraint (SIR) warning lamp was OFF indicating no error conditions in the automatic restraint system, the driver's seat belt was buckled and the deployment event occurred during ignition cycle 2,626 (**Figure 8**). The case vehicle was traveling approximately 89 km.p.h. [55 m.p.h.] with 3 percent throttle five seconds prior to the impact. The driver pumped the brakes on, off and on again over the next four seconds and the vehicle slowed to 31 km.p.h. [19 m.p.h.] at one second prior to the impact (**Figures 8** and **9**). The case vehicle driver and front right passenger air bags were equipped with multi-stage inflators. The SDM report indicates that the command for first stage deployment was issued at 45 milliseconds [0.045 seconds] after algorithm enable and the criteria for second stage deployment were not met (**Figure 8**). The SDM report indicates that the maximum recorded velocity change was -8.6 km.p.h. [-5.35 m.p.h.] at 107.5 milliseconds [0.1075 seconds] after algorithm enable (**Figure 8**). The velocity change data show deltaV accumulating gradually to the maximum at approximately 110 milliseconds following algorithm enable. Recording stopped at 140 milliseconds (**Figures 8** and **10**). The WinSMASH barrier algorithm calculated longitudinal deltaV for the case vehicle was -15.3 km.p.h. [-9.5 m.p.h.].

CASE VEHICLE DRIVER

Immediately prior to the crash the case vehicle's driver (45-year-old female, white, non-Hispanic, 168 centimeters, 95 kilograms [66 inches, 210 pounds]) was seated in an upright posture with her back against the seat back, her left foot on the floor, her right foot on the foot controls, and both hands on the steering wheel. Her seat track was located between its middle and rear-most positions, the seat back was sightly reclined, and the tilt steering wheel was adjusted at its middle position. She was restrained by her available, active, three-point, lap-and-shoulder, safety belt system. There was moderate waving/stretching of the belt webbing and the EDR download indicated that the driver's safety belt buckle was fastened. Inspection of the case vehicle's interior revealed no other evidence of occupant contact on the interior surfaces of the case vehicle.

The case vehicle encountered a patch of ice and went out of control. The driver reported that, in an effort to avoid crashing the vehicle, she released the accelerator, pumped the brakes and

tried to steer the vehicle back into control. Her posture probably did not change as a result of these attempted avoidance actions, except that her muscles were tensed in a heightened state of alertness. The vehicle ran off the road to the left and the front tilted down as it traversed the drop off at the edge of the road. The case vehicle's impact with the utility pole caused the driver to move forward and slightly rightward and upward, toward the 1 o'clock direction of force. The safety belt retractor locked, holding her in place, and she encountered the deployed driver's air bag with her face and chest. Because she was restrained by the belt, she did not load heavily into the air bag. Because she was cushioned by the air bag, she did not load heavily against the safety belt webbing. Her left leg flailed and impacted the knee bolster. She rebounded into her seat as the vehicle came to rest.

CASE VEHICLE DRIVER INJURIES

According to her interview, the driver sustained a large bruise in the area of her left knee and no other injuries, and she did not seek any medical treatment.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1.	Contusion, left knee	890402.1 minor	Knee bolster	Probable	Interviewee (same person)

2G1WW12E629[redacted] System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	BUCKLED
Ignition Cycles At Deployment	2626
Ignition Cycles At Investigation	2627
Maximum SDM Recorded Velocity Change (MPH)	-5.35
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)	107.5
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	45
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)	45
Passenger Second Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)	N/A
Time Between Non-Deployment And Deployment Events (sec)	N/A
Frontal Deployment Level Event Counter	1
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	-1.24	-1.55	-2.17	-3.10	-3.41	-4.34	-4.65	-4.96	-4.96	-5.27	-5.27	-4.96	-4.96	N/A

PRE-CRASH DATA

Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	55	1280	3	OFF
-4	47	896	3	ON
-3	45	768	3	OFF
-2	37	640	3	ON
-1	19	512	3	ON

Figure 8: Sensing Diagnostic Module (SDM) System Status at Deployment

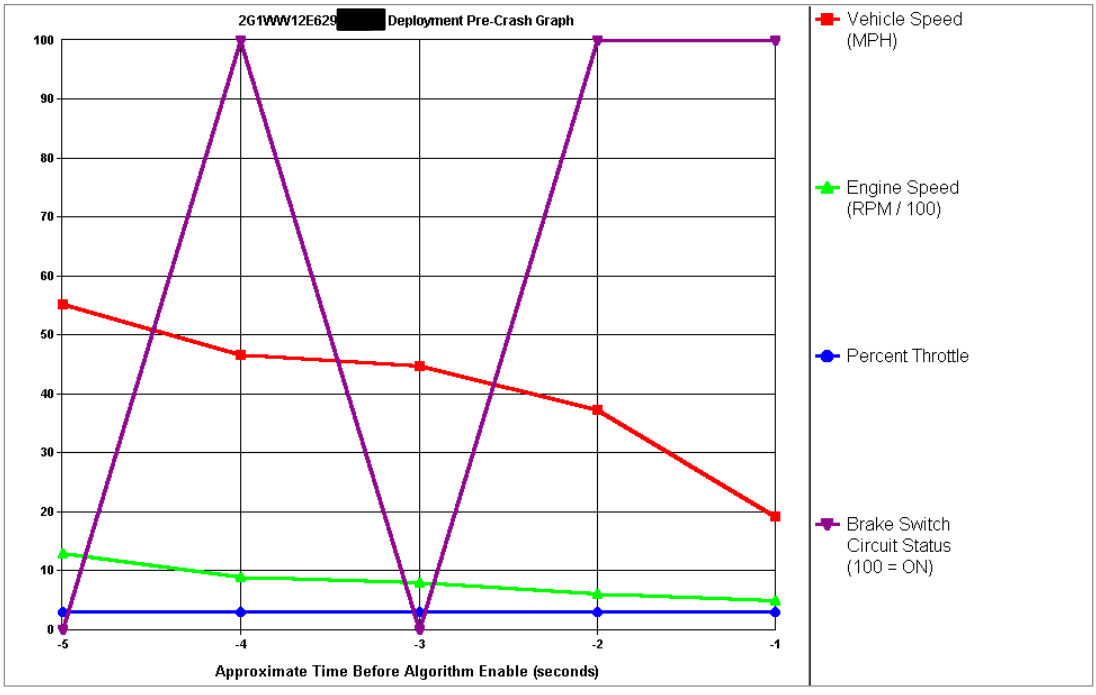


Figure 9: SDM Pre-Crash Graph, showing data presented in Figure 6

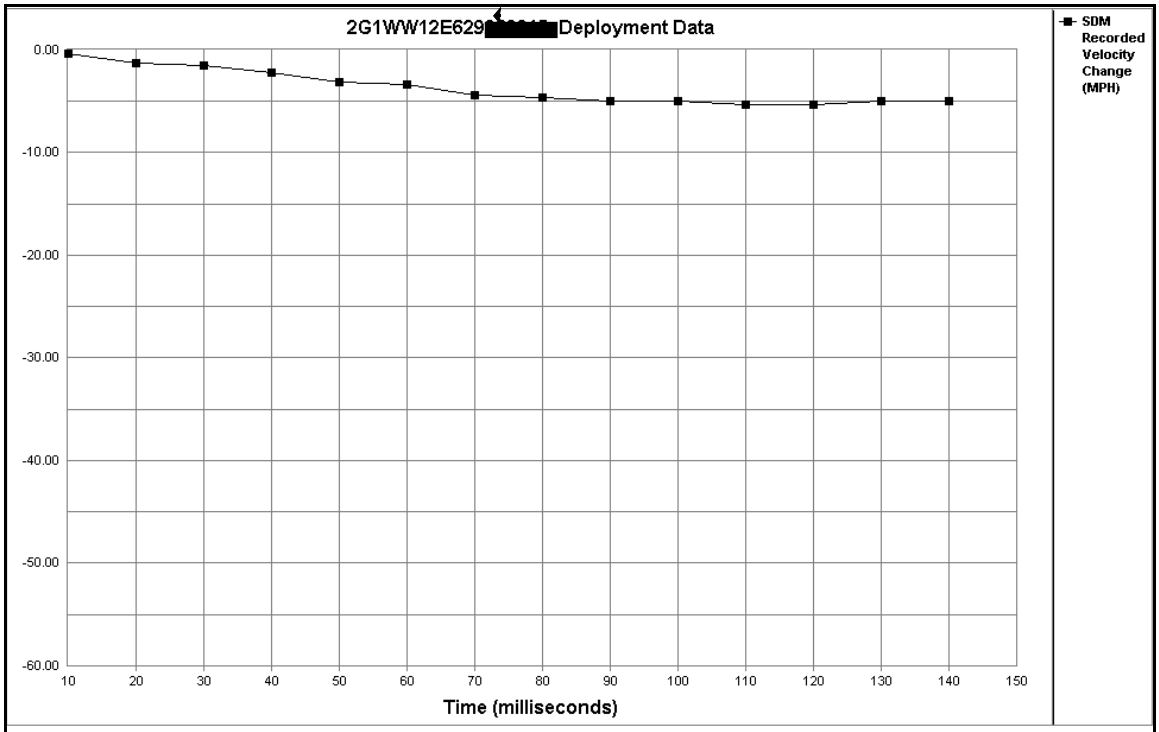
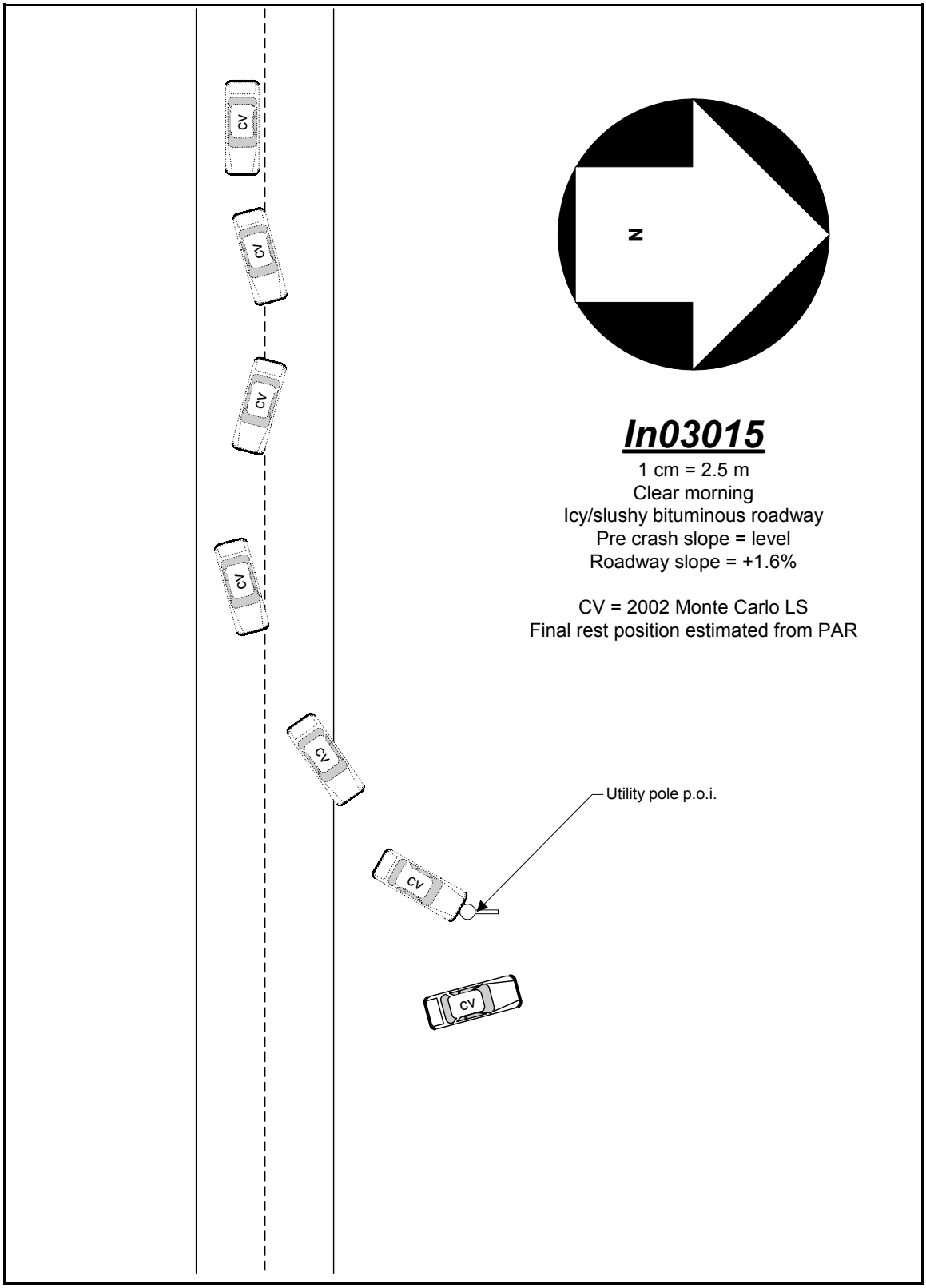


Figure 8: SDM Velocity Change Graph, showing data presented in Figure 6


CV
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N
In03015
1 cm = 2.5 m
Clear morning
Icy/slushy bituminous roadway
Pre crash slope = level
Roadway slope = +1.6%
CV = 2002 Monte Carlo LS
Final rest position estimated from PAR
Utility pole p.o.i.