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ON-SITE CERTIFIED ADVANCED 208- COMPLIANT VEHICLE INVESTIGATION

CASE NUMBER - IN-04-005

LOCATION - MISSOURI

VEHICLE - 2003 CHEVROLET SILVERADO

CRASH DATE - December 2003

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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. <i>Abstract</i> This report covers an on-site investigation of an air bag deployment crash that involved a 2003 Chevrolet Silverado (case vehicle) which ran-off-road and impacted a concrete longitudinal median barrier. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including manufacturer certified advanced 208-compliant air bags that deployed as a result of the crash events, and the case vehicle's unrestrained driver (43-year-old, female) and unrestrained front right passenger (57-year-old, male) sustained only minor injuries as a result of the crash. The case vehicle was traveling northeast in the inside lane of an eight lane divided Interstate highway. The case vehicle's driver lost control of the vehicle on the snow and ice covered roadway, and the front of the case vehicle impacted the concrete longitudinal median barrier causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle's driver braked briefly prior to the impact. The case vehicle's driver was seated with her seat track located in its middle position and the steering wheel located in its center position. She was not using her available, active, three-point, lap-and-shoulder safety belt system and sustained, according to her emergency room records, a sprain to her right shoulder. The front right passenger was seated with his seat track located in its rearmost position. He was grasping the grab bar located above his air bag module bracing for the impact and was likely leaning forward and to the left. He was not using his available, active, three-point, lap-and-shoulder safety belt system. He sustained, according to the interview with the case vehicle's driver, minor injuries which included: a bloody nose, a cut to the left side of his nose and a cut on an unknown knee.					
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This on-site investigation was brought to NHTSA's attention on or about February 5, 2004 by NASS GES sampling activities. This crash involved a 2003 Chevrolet Silverado pickup truck (case vehicle) that ran-off-road and impacted a longitudinal concrete median barrier and a guardrail. The crash occurred in December 2003, at 9:10 p.m., in Missouri and was investigated by the applicable county police department. This crash is of special interest because the case vehicle was equipped with multiple Advanced Occupant Protection System (AOPS) features, including certified advanced 208-compliant air bags, as well as an Event Data Recorder (EDR), and the case vehicle's driver [43-year-old, White (non-Hispanic) female] and front right passenger [57-year-old White (non-Hispanic) male] sustained minor injuries in the crash. In addition, the manufacturer of the case vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208. This contractor inspected the scene and vehicle on February 20, 2004 and downloaded the data from the onboard EDR. This contractor interviewed the driver on March 16, 2004. This report is based on the police crash report, an interview with the case vehicle's driver, scene and vehicle inspections, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

Crash Environment: The trafficway on which the case vehicle was traveling was an eight-lane, divided, Interstate highway, traversing in a northeasterly and southwesterly direction. At the time of the crash the light condition was dark, but illuminated by overhead street lamps in the area of impact. The atmospheric condition was snowy, and the roadway pavement was snow covered, travel polished bituminous and concrete with areas of ice on the roadway. Traffic density was light, and the crash site was a combination of residential and undeveloped area. See the **Crash Diagram** at the end of this report.

Pre-Crash: The case vehicle was traveling northeast in the inside through lane, and the driver was intending to continue straight ahead. The case vehicle's driver reported that she contacted a patch of ice on the roadway and lost control of the case vehicle. She applied the brakes briefly prior to the crash. The crash occurred off the roadway to the left.

Crash: The front left of the case vehicle impacted a concrete longitudinal median barrier, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The case vehicle then deflected clockwise off the median barrier and the left quarter panel sustained a minor secondary sideswipe impact with the median barrier. As a result of the frontal impact, the case vehicle rotated clockwise an unknown number of rotations and traversed diagonally across all four lanes of northeastbound traffic. The case vehicle departed the right side of the roadway, and the front left impacted a metal guardrail. The case vehicle continued to rotate clockwise and travel backwards, and the left quarter panel sustained a second minor sideswipe impact with the guardrail.

Post-Crash: The case vehicle separated slightly from the guardrail and came to final rest parallel to the guardrail facing opposite its original travel direction.

Case Vehicle: The 2003 Chevrolet C1500 Silverado was a rear wheel drive (4x2), two-door, regular cab pickup truck (VIN: 1GCEC14X83Z-----). The case vehicle was equipped with four wheel, anti-lock brakes; integrated, three- point, lap and shoulder safety belt systems in the driver and front right seats, dual stage driver and front right passenger air bag inflators, occupant detection sensor in the front right seat and an EDR contained within the vehicle's Sensing and Diagnostic Module (SDM). Furthermore, the case vehicle was equipped with an air bag suppression switch for the front right passenger air bag. Traction control was an option, but it is not known if the case vehicle was so equipped.

Vehicle Exterior: Based on the police crash report, vehicle and crash site inspections and the available photographs it was determined there was overlapping damage to the front of the case vehicle and the left quarter panel from the impacts with the concrete median barrier and the guardrail. It was determined that these damages could be separated. The CDC for the case vehicle's impact with the concrete median barrier was determined to be: **11-FYEW-1 (330 degrees)**. The CDC for the guardrail impact was determined to be: **11-FYEW-1 (330 degrees)**. The CDCs for the sideswipe damages to the left quarter panel were determined to be: **12-LBES-2 (0 degrees)** for the concrete median barrier impact, and **06-LBLS-2 (180 degrees)** for the guardrail impact. The case vehicle was towed due to damage

Due to the overlapping damage to the front of the case vehicle, the WinSMASH reconstruction program could not be used to reconstruct Delta-V and could not be applied to the sideswipe impacts (sideswipes are out-of-scope for WinSMASH). The damage to the front of the case vehicle indicates that the crash severity was moderate [24-40 km.p.h. (15 to 25 m.p.h.).

Exterior Damage: The case vehicle's contact with the concrete median barrier involved approximately the left half of the front plane including the bumper, grille, hood and front of the left fender. There was also overlapping damage from the subsequent guardrail impact in the same area. Direct damage began at the left front bumper corner and extended 82 centimeters (32.3inches) along the front bumper. Residual maximum crush was measured as 21centimeters (8.3 inches) at C₁. Direct damage from the sideswipe impacts to the left quarter panel from the concrete median barrier and the guardrail began at the back left bumper corner and extended 59 centimeters (23.2 inches) forward. There was no residual crush from this impact. The case vehicle's wheelbase was unaltered from the crash. The case vehicle's front bumper, grille, left headlamp/turn lamp assemblies, left fender and hood were directly damaged and crushed rearward. The case vehicle's windshield sustained a slight crack due to induced damage. No other obvious induced damage or remote buckling was noted to the remainder of the case vehicle's exterior.

The case vehicle's recommended tire size was: P235/75R16 and the vehicle was equipped with tires of this size. The case vehicle's tire data are shown in the table below.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	159	23	193	28	8	10	None	No	No
RF	234	34	193	28	8	10	None	No	No
LR	234	34	241	35	7	9	None	No	No
RR	234	34	241	35	7	9	None	No	No

Vehicle Interior: Inspection of the case vehicle's interior revealed a minor bend to the top of the steering wheel rim and a contact scuff to the left side of the driver's knee bolster. In addition, there was no evidence of intrusion to the case vehicle's interior. Finally, it could not be determined if there was any compression to the energy absorbing shear capsules in the steering column.

Supplemental Restraints: 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 fabric revealed that the cover flaps opened at the designated tear points. 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 two tethers, each approximately 14 centimeters (5.5 inches) in width. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 11 and 1 o'clock positions. The deployed driver's air bag was round with a diameter of 66 centimeters (26.0 inches). An inspection of the driver's air bag revealed no evidence of occupant contact.

The front right passenger's air bag was located in the middle of the instrument panel. An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flap opened at the designated tear points. There was no evidence of damage during the deployment to the air bag or the cover flap. The front right passenger's air bag was designed with one wide tether, approximately 37 centimeters (14.6 inches) in width. The front right air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter, located at the 9:30 and 2:30 clock positions. The deployed front right air bag was rectangular with a height of approximately 49 centimeters (19.3 inches) and a width of approximately 60 centimeters (23.6 inches). An inspection of the air bag fabric revealed a pair of small blood stains on the far upper right side of the front of the bag, a blood stain on the upper left corner on the top side of the bag and a similar stain on the upper left corner of the air bag, toward the front edge.

Crash Data Recording: The EDR data showed the vehicle sustained a deployment event (i.e., impact to the concrete median barrier) and a deployment level event (i.e., recorded as a non-deployment event). A deployment level event (i.e., an event severe enough to deploy the air bags had they not already been deployed in a prior event) will be recorded and locked in the EDR memory if it occurs within five seconds after a deployment event. The deployment level event is

therefore associated with the guardrail impact. The EDR data indicates it was a higher severity impact than the deployment event.

The EDR data of interest for the deployment event indicate the SIR warning lamp was off and the driver's seat belt was unbuckled. The case vehicle's travel speed was 122 km.p.h. (76 m.p.h.) five seconds prior to algorithm enable, and maximum SDM recorded velocity change (i.e., longitudinal component of Delta-V) was -15.5 km.p.h. (-9.62 m.p.h.) occurring at 177.5 milliseconds following algorithm enable. Lastly, the data indicate that only the first stage deployment criteria was met for the driver and front right passenger air bag modules. This occurred 30 milliseconds after the first stage time algorithm was enabled.

Case Vehicle's Driver: Immediately prior to the crash the case vehicle's driver [43-year-old, White (non-Hispanic) female; 165 centimeters and 96 kilograms (65 inches, 211 pounds)] was seated in a generally upright posture with her back against the seat back, her feet on the floor, and both hands on the steering wheel. Her seat track was located in its middle position, the seat back was slightly reclined, the tilt steering wheel was located in its center position, and she was not using her available, active, three-point, integral lap-and-shoulder, safety belt system. The driver applied the brakes briefly prior to the initial impact.

Due to the pre-impact motion of the case vehicle, the driver may have been leaned somewhat to the left just prior to impact. The case vehicle's primary impact with the concrete median barrier enabled the driver to continue forward and leftward along a path opposite the case vehicle's 330 degree Direction of Principal Force as the case vehicle decelerated. As a result, the driver most likely contacted her deployed driver air bag.

Following the initial impact, the case vehicle deflected off the concrete median barrier and rotated clockwise an unknown number of times as it crossed the roadway. The front left then collided with a metal guardrail on the right side of the roadway. The driver remained in her seat just prior to the guardrail impact and likely had both hands on the steering wheel. As a result of the front impact with the guardrail, the driver moved forward and to her left and her chest impacted the steering wheel, and her left knee impacted the knee bolster. The driver most likely rebounded back into her seat and remained in her seat as the case vehicle came to final rest. The driver was able to exit the case vehicle under her own power through the right front door.

The driver was not transported by ambulance to the hospital. She sustained minor injuries and sought treatment later at a medical center emergency room. According to her interview and medical records, she sustained soft tissue injuries that included: a sprain right shoulder and complaint of chest pain. The injuries most likely resulted from contact with the steering wheel. The driver did not receive any follow-up treatment and was not working prior to the crash

Case Vehicle's Front Right Passenger: The case vehicle's front right passenger [57-year-old, White (non-Hispanic) male; 180 centimeters and 97.5 kilograms (71 inches, 215 pounds)] was seated with both feet on the floor in a generally upright posture. However, it is likely he may have been leaning forward and to the left to some degree due to the case vehicle's rotation and because he was grasping a grab-bar located on the top edge of the instrument panel above the air

bag module. His seat track was located in its rearmost position, the seat back was slightly reclined, and he was not using his available, active, three-point, integral lap-and-shoulder, safety belt system.

Due to the pre-impact motion of the case vehicle, the front right passenger may have been leaned somewhat to the left just prior to impact. The case vehicle's primary impact with the concrete median barrier enabled the front right passenger to continue forward and leftward along a path opposite the case vehicle's 330 degree Direction of Principal Force as the case vehicle decelerated and he contacted his deploying air bag. The passenger then likely rebounded back into his seat.

The motion of the passenger between the median barrier impact and the guardrail impact is not known. The passenger likely remained in his seat just prior to the guardrail impact, but the position of his body is not known. The passenger likely remained on the seat as the case vehicle came to final rest. The passenger was able to exit the case vehicle under his own power through the right front door.

The front right passenger was not transported by ambulance to the hospital. He sustained minor injuries but did not receive any medical treatment. According to the interview with the case vehicle's driver, the passenger sustained a bloody nose, a cut on the left side of the nose from his eye glasses, and a 2.5 centimeter (1 inch) cut on an unknown knee. The bloody nose and cut on the left side of his nose most likely resulted from contact with his deployed air bag. The source of the cut on the passenger's knee is unknown. The passenger was not working prior to the crash.

CRASH CIRCUMSTANCES

Crash Environment: The trafficway on which the case vehicle was traveling was an eight-lane, divided, Interstate highway, traversing in a northeasterly and southwesterly direction. The trafficway was divided by a concrete median barrier, and the case vehicle's roadway contained four travel lanes (**Figure 1**). The case vehicle's approach to the crash location was uncontrolled and the speed limit was 97 km.p.h. (60 m.p.h.). There was no regulatory speed limit sign posted near the crash site. The interstate highway was straight and level, and the pavement was snow covered, travel polished bituminous and concrete with areas of ice on the roadway. Each travel lane was nominally 3.7 meters wide (12 feet). The shoulders were bituminous and the shoulder widths are unknown. The roadway pavement markings consisted of single broken white lane lines, a white outside edge line and a yellow inside median line. The estimated coefficient of friction of the snow and ice covered roadway surface was 0.25. At the time of the crash the light condition was dark, but illuminated by overhead street

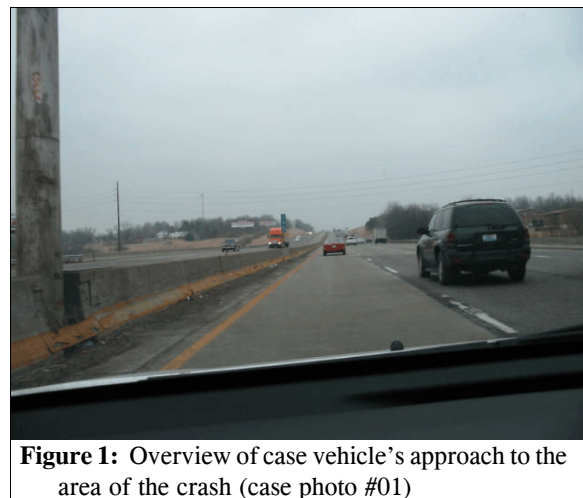


Figure 1: Overview of case vehicle's approach to the area of the crash (case photo #01)

lamps in the area of impact. The atmospheric condition was snowy and traffic density was light. The crash site was a combination of residential and undeveloped area. See the **Crash Diagram** at the end of this report.

Pre-Crash: The case vehicle was traveling northeast (**Figure 2**) in the inside through lane at an EDR indicated speed of 122 km.p.h. (76 m.p.h.), and the driver was intending to continue straight ahead. The case vehicle's driver reported that she contacted a patch of ice on the roadway and lost control of the case vehicle. The driver braked briefly prior to the crash. The crash occurred off the roadway to the left.

Crash: The front left (**Figure 3**) of the case vehicle impacted the concrete longitudinal median barrier, causing the case vehicle's driver and front right passenger supplemental restraints (air bags) to deploy. The EDR data indicated that only the first stage of the dual stage air bags activated. The case vehicle then deflected clockwise off the median barrier and the left quarter panel sustained a minor secondary sideswipe impact with the median barrier (**Figure 4**). As a result of the frontal impact, the case vehicle rotated clockwise an unknown number of rotations and traversed diagonally across all four lanes of northeastbound traffic. The case vehicle departed the right side of the roadway, and the front left impacted a metal guardrail. The case vehicle continued to rotate clockwise and traveled backwards, and the left quarter panel sustained a minor sideswipe impact with the guardrail (**Figure 4**).

Post-Crash: The case vehicle separated slightly from the guardrail and came to final rest parallel to the guardrail facing opposite its original travel direction.



Figure 2: Approach of case vehicle northeastbound to impact with the concrete longitudinal median barrier (case photo #02)



Figure 3: Oblique view of front and left sides of case vehicle showing direct damage to the front, each stripe on rods is 5 cm (2 in), (case photo #08)



Figure 4: Damage to left quarter panel from impacts with concrete median barrier (green arrows) and guardrail [red arrows (case photo #11)]

The 2003 Chevrolet C1500 Silverado was a rear wheel drive (4x2), two-door, regular cab pickup truck (VIN: 1GCEC14X83Z-----). The case vehicle was equipped with four wheel, anti-lock brakes; integrated, three-point, lap and shoulder safety belt systems in the driver and front right seats, dual stage driver and front right passenger air bag inflators, occupant detection sensor in the front right seat and an EDR contained within the vehicle's Sensing and Diagnostic Module (SDM). Furthermore, the case vehicle was equipped with an air bag suppression switch for the front right air bag. Traction control was an option, but it is not known if the case vehicle was so equipped. Lastly, the manufacturer of this vehicle has certified that it meets the advanced air bag requirements of Federal Motor Vehicle Safety Standard (FMVSS) No. 208.

The various sensors in the case vehicle's advanced occupant restraint system analyze a combination of factors including the predicted crash severity to determine the front air bag inflation level appropriate for the severity of the crash. For the front right seat position, an occupant weight pressure sensor and a seat belt tension sensor provide data to the electronic control module. The electronic control module compares the seat pressure and seat belt tension data to threshold values, determines if the front right air bag should be suppressed or enabled and communicates the decision to the air bag control module. The air bag will be suppressed when the seat pressure is at or below what a 6-year-old child in a booster seat produces or when the belt tension is above 6.8 kilograms (15 pounds). The air bag will be enabled if the seat pressure is at or above what a 46.7 kilograms (103 pound) occupant produces and the seat belt tension is below 6.8 kilograms (15 pounds).

CASE VEHICLE DAMAGE

Exterior Damage: The case vehicle's contact with the concrete median barrier involved approximately the left half of the front plane including the bumper, grille, hood and front of the left fender. There was also overlapping damage from the subsequent guardrail impact in the same area. Direct damage began at the left front bumper corner and extended 82 centimeters (32.3 inches) along the front bumper. Residual maximum crush was measured as 21 centimeters (8.3 inches) at C₁ (**Figure 5**). Direct damage from the sideswipe impacts to the left quarter panel from the concrete median barrier and the guardrail began at the back left bumper corner and extended 59 centimeters (23.2 inches) forward. There was no residual crush from these impacts. The table below shows the case vehicle's crush profile.



Figure 5: Left side view of crush to front of case vehicle (case photo #09)

Units	Events	Direct Damage		Field L	C ₁	C ₂	C ₃	C ₄	C ₅	C ₆	Direct	Field L
		Width CDC	Max Crush								±D	±D
cm	1&3	82	21	165	21	15	10	7	8	17	-41	0
in		32.3	8.3	65.0	8.3	5.9	3.9	2.8	3.2	6.7	-16.1	0.0

The case vehicle’s wheelbase was unaltered from the crash. The case vehicle’s front bumper, grille, left headlamp/turn lamp assemblies, left fender and hood were directly damaged and crushed rearward. The case vehicle’s windshield sustained a slight crack due to induced damage. No other obvious induced damage or remote buckling was noted to the remainder of the case vehicle’s exterior.

The case vehicle’s recommended tire size was: P235/75R16 and the vehicle was equipped with tires of this size. The case vehicle’s tire data are shown in the table below.

Tire	Measured Pressure		Recommend Pressure		Tread Depth		Damage	Restricted	Deflated
	kpa	psi	kpa	psi	milli-meters	32 nd of an inch			
LF	159	23	193	28	8	10	None	No	No
RF	234	34	193	28	8	10	None	No	No
LR	234	34	241	35	7	9	None	No	No
RR	234	34	241	35	7	9	None	No	No

Vehicle Interior: Inspection of the case vehicle’s interior revealed a minor bend to the top of the steering wheel rim (**Figure 6**) and a contact scuff to the left side of the driver’s knee bolster (**Figure 7** below). In addition, there was no evidence of intrusion to the case vehicle’s interior. Finally, it could not be determined if there was any compression to the energy absorbing shear capsules in the steering column.



Figure 6: Case vehicle’s steering assembly viewed from right showing deformation to upper portion of rim (case photo #28)

Damage Classification: Based on the police crash report, vehicle and crash site inspections and the available photographs it was determined there was overlapping damage to the front of the case vehicle and the left quarter panel from the impacts with the concrete median barrier and the guardrail. It was determined that these damages could

be separated. The CDC for the case vehicle's impact with the concrete median barrier was determined to be: **11-FYEW-1 (330 degrees)**. The CDC for the guardrail impact was determined to be: **11-FYEW-1 (330 degrees)**. The CDCs for the sideswipe damages to the left quarter panel were determined to be: **12-LBES-2 (0 degrees)** for the concrete median barrier impact, and **06-LBLS-2 (180 degrees)** for the guardrail impact. The case vehicle was towed due to damage.

Due to the overlapping damage to the front of the case vehicle, the WinSMASH reconstruction program could not be used to reconstruct the Delta-Vs and could not be applied to the sideswipe impacts (sideswipes are out of scope for WinSMASH). The EDR recorded the maximum longitudinal component of Delta-V for the impact with the concrete median barrier as: -15.5 km.p.h. (-9.62 m.p.h.). The maximum longitudinal component of Delta-V for the guardrail impact was recorded as -29.6 km.p.h. (-18.37 m.p.h.). Therefore, based on the EDR data the case vehicle's crash severity was determined to be moderate [24-40 km.p.h. 15-25 m.p.h.).

AUTOMATIC RESTRAINT SYSTEM

The case vehicle was equipped with a Supplemental Restraint System (SRS) that contained manufacturer certified advanced 208-compliant frontal air bags at the driver and front right passenger positions. Both front air bags deployed as a result of the case vehicle's impact with the concrete median barrier. The EDR data indicated that the first stage of the dual stage air bag inflators deployed for both the driver and front right air bags.

The case vehicle's driver air bag was located in the steering wheel hub. The module cover consisted of symmetrical "I"-configuration cover flaps made of thick vinyl (**Figure 8**). Each cover flap was 12 centimeters (4.7 inches) in width at the top seam, 11 centimeters (4.3) in width at the bottom seam and 11.5 centimeters (4.5) in height along the vertical seam between the two flaps. The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection (i.e., seat in full rear position,



Figure 7: Tape shows scuff on driver's left knee bolster (case photo #29)

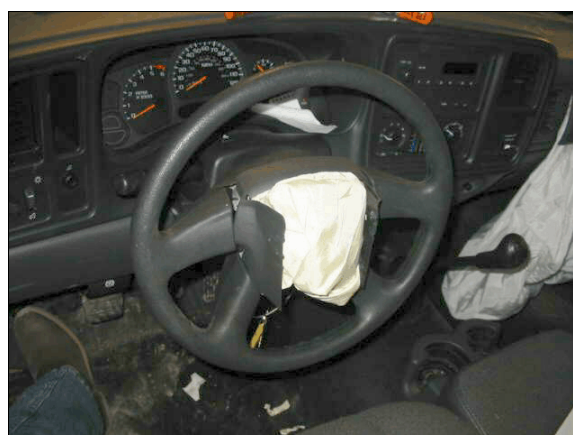


Figure 8: Case vehicle's steering wheel and air bag module flaps (case photo #32)



Figure 9: The driver's air bag (case photo #31)

seat back slightly reclined), and the front surface of the air bag's fabric at full excursion was 42 centimeters (16.5). An inspection of the air bag module's cover flaps and air bag fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage during the deployment to the air bag or the cover flaps. The deployed driver's air bag (**Figure 9** above) was round with a diameter of 66 centimeters (26.0 inches), and the air bag was designed with two tethers, each approximately 14 centimeters (5.5 inches) in width. The driver's air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter located at the 11 and 1 o'clock positions. An inspection of the driver's air bag revealed no evidence of occupant contact.

The front right passenger's air bag was located in the middle of the instrument panel. There was a single, essentially rectangular, module cover flap (**Figure 10**). The cover flap was made of semi-pliable vinyl. The cover flaps dimensions were 39 centimeters (15.4 inches) at the bottom horizontal seam and 14 centimeters (5.5 inches) along both vertical seams. The profile of the case vehicle's instrument panel was flush with the leading edge of the cover flap. The distance between the mid-center of the front right seat back, as positioned at the time of the crash (i.e., seat full rear, seat back slightly reclined), and the front surface of the air bag's fabric at full excursion was 46 centimeters (18.2 inches). An inspection of the front right air bag module's cover flap and the air bag's fabric revealed that the cover flaps opened at the designated tear points. There was no evidence of damage during the deployment to the air bag or the cover flap.

The deployed front right air bag (**Figure 11**) was rectangular with a height of approximately 49 centimeters (19.3 inches) and a width of approximately 60 centimeters (23.6 inches), and was designed with one wide tether, approximately 37 centimeters (14.6 inches) in width. The front right air bag had two vent ports, approximately 3 centimeters (1.2 inches) in diameter (**Figure 12** below), located at the 9:30 and 2:30 clock positions. An inspection of the air bag fabric revealed a pair of small blood stains on the far upper right side of the front of the bag, a blood stain on the upper left corner on the top side of the bag and a similar stain on the upper left corner of the bag, toward the front edge.



Figure 10: Overview of front right air bag module flap, indicated by arrow (case photo #38)



Figure 11: Front right passenger air bag. Yellow tape shows location of blood stains (case photo #33)

CRASH DATA RECORDING

The data download from the case vehicle's EDR was completed in the field. The data showed the vehicle sustained a deployment event (i.e., impact with the concrete median barrier) and a deployment level event (recorded as a non-deployment event). A deployment level event (i.e., an event severe enough to deploy the air bags had they not already been deployed in a prior event) will be recorded and locked in the EDR memory if it occurs within five seconds after a deployment event. The deployment level event is therefore associated with the guardrail impact. The EDR data indicates it was a higher severity impact than the deployment event.



Figure 12: Vent port of left side of front right passenger air bag and blood stain (case photo #36)

The system status report and associated graphs for the deployment event are presented in **Figures 13-15** at the end of this report. They indicate the SIR warning lamp was off, the driver's seat belt was unbuckled and the vehicle's speed was 122 km.p.h. (76 m.p.h.) five seconds prior to algorithm enable decreasing to 97 km.p.h. (60 m.p.h.) one second prior to algorithm enable. Also, the pre-crash data indicates the brake light circuit was on three seconds prior to algorithm enable, then off two seconds prior to algorithm enable and maximum SDM recorded velocity change (i.e., longitudinal component of Delta-V) was -15.5 km.p.h. (-9.62 m.p.h.) occurring at 177.5 milliseconds following algorithm enable. Lastly, the data indicate that only the first stage deployment criteria was met for the driver and front right passenger air bag modules. This occurred 30 milliseconds after the first stage time algorithm was enabled.

The system status report and associated graphs for the deployment level event (i.e., recorded as a non-deployment event) are presented in **Figures 16-18** at the end of this report. The data show a maximum SDM recorded velocity change of -29.6 km.p.h. (-18.37 m.p.h.) occurring at 257.5 milliseconds after algorithm enable. The data also indicate that the event recording was complete and there was one or more associated events not recorded. It appears likely that the non-recorded event was the sideswipe impact between the left quarter panel of the case vehicle and the guardrail.

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash the case vehicle's driver [43-year-old, White (non-Hispanic) female; 165 centimeters and 96 kilograms (65 inches, 211 pounds)] was seated in a generally upright posture with her back against the seat back, her feet on the floor, and both hands on the steering wheel. Her seat track was located in its middle position, the seat back was slightly reclined, and the tilt steering wheel was located in its center position.

Based on this contractor's inspection of the safety belt system and supported by the EDR data, the case vehicle's driver was not using her available, active, three-point, integral lap-and-shoulder, safety belt system. Furthermore, there was no mention by the driver of belt pattern bruising or abrasions to her torso, and the inspection of the driver's seat belt webbing, shoulder belt guide, and latch plate showed no evidence of loading.

The case vehicle's driver stated she made no pre-crash avoidance maneuvers. However, the EDR data indicated that the brake switch circuit was on three seconds prior to algorithm enable and then off at two seconds prior to algorithm enable. This indicates the driver most likely applied the brakes during the initial loss of control. It is likely the driver also initiated some evasive steering maneuver, although she had no recollection of making any such avoidance maneuver. Due to the pre-impact motion of the case vehicle, the driver may have been leaned somewhat to the left just prior to impact. The case vehicle's primary impact with the concrete median barrier caused the driver to continue forward and leftward along a path opposite the case vehicle's 330 degree Direction of Principal Force as the case vehicle decelerated. As a result, the driver most likely contacted her deployed driver air bag.

Following the initial impact, the case vehicle deflected off the concrete median barrier and rotated clockwise an unknown number of times as it crossed the roadway. The motion of the driver during this period is not known. The front left then collided with a metal guardrail on the right side of the roadway. The driver likely remained in her seat just prior to the guardrail impact and likely had both hands on the steering wheel. As a result of the front impact with the guardrail, the driver moved forward and to her left and her chest impacted the steering wheel, and her left knee impacted the knee bolster. The driver most likely rebounded back into her seat and remained in her seat as the case vehicle came to final rest. The driver was able to exit the case vehicle under her own power through the right front door.

CASE VEHICLE DRIVER INJURIES

The driver was not transported by ambulance to the hospital. She sustained minor injuries and sought treatment later at a medical center emergency room. According to her interview and medical records, she sustained soft tissue injuries that included: a sprain right shoulder and complaint of chest pain. The injuries most likely resulted from contact with the steering wheel. The driver did not receive any follow-up treatment and was not working prior to the crash.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Sprain right shoulder, not further specified	minor 751020.1,1	Steering wheel rim	Probable	Emergency room records

The case vehicle's front right passenger [57-year-old, White (non-Hispanic) male; 180 centimeters and 97.5 kilograms (71 inches, 215 pounds)] was seated with both feet on the floor in a generally upright posture. However, it is likely he may have been leaning forward and to the left to some degree due to the case vehicles rotation and because he was grasping a grab-bar located on the top edge of the instrument panel above the air bag module. His seat track was located in its rearmost position and the seat back was slightly reclined.

The case vehicle's front right passenger was not using his available, active, three-point, integral lap-and-shoulder, safety belt system. Furthermore, there was no mention by the driver of belt pattern bruising and/or abrasions to the passenger's body, and inspection of the front right passenger's seat belt webbing, shoulder belt guide, and latch plate revealed no evidence of loading.

Due to the pre-impact motion of the case vehicle, the front right passenger may have been leaned somewhat to the left just prior to impact. The case vehicle's primary impact with the concrete median barrier caused the front right passenger to continue forward and leftward along a path opposite the case vehicle's 330 degree Direction of Principal Force as the case vehicle decelerated and he contacted his deploying air bag. The passenger then likely rebounded back into his seat.

Following the initial impact, the case vehicle deflected off the concrete median barrier and rotated clockwise an unknown number of times as it crossed the roadway. The motion of the passenger during this period is not known. The front left then collided with a metal guardrail on the right side of the roadway. The front right passenger likely remained in his seat just prior to the guardrail impact but the position of his body is not known. The passenger likely remained on the seat as the case vehicle came to final rest. The passenger was able to exit the case vehicle under his own power through the right front door.

CASE VEHICLE FRONT RIGHT PASSENGER INJURIES

The front right passenger was not transported by ambulance to the hospital. He sustained minor injuries but did not receive any medical treatment. According to the interview with the case vehicle's driver, the passenger sustained a bloody nose, a cut on the left side of the nose from his eye glasses, and a 2.5 centimeter (1 inch) cut on an unknown knee. The bloody nose and cut on the left side of his nose most likely resulted from contact with his deployed air bag. The contact source for the cut on the knee is unknown. The passenger was not working prior to the crash.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Laceration {cut} on side of nose, not further specified	minor 290600.1,4	Air bag, passenger's and eye wear	Probable	Interviewee (driver)
2	Laceration {cut}, 2.5 cm (1 in) on knee, unknown left or right	minor 890602.1,9	Unknown	Unknown	Interviewee (driver)

1GCEC14X83Z																System Status At Deployment				
SIR Warning Lamp Status																OFF				
Driver's Belt Switch Circuit Status																UNBUCKLED				
Ignition Cycles At Deployment																1690				
Ignition Cycles At Investigation																1702				
Maximum SDM Recorded Velocity Change (MPH)																-9.62				
Algorithm Enable to Maximum SDM Recorded Velocity Change (msec)																177.5				
Driver First Stage Time Algorithm Enabled to Deployment Command Criteria Met (msec)																30				
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)																30				
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)	-0.62	-1.24	-1.86	-3.10	-4.34	-5.58	-6.51	-7.44	-8.37	-8.68	-8.99	-9.30	-9.30	N/A	N/A					
PRE-CRASH DATA																				
Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status																
-5	76	2240	40	OFF																
-4	71	2048	0	OFF																
-3	69	1920	0	ON																
-2	66	1856	0	OFF																
-1	60	1664	0	OFF																

Figure 13: Case vehicle's System Status at Deployment report

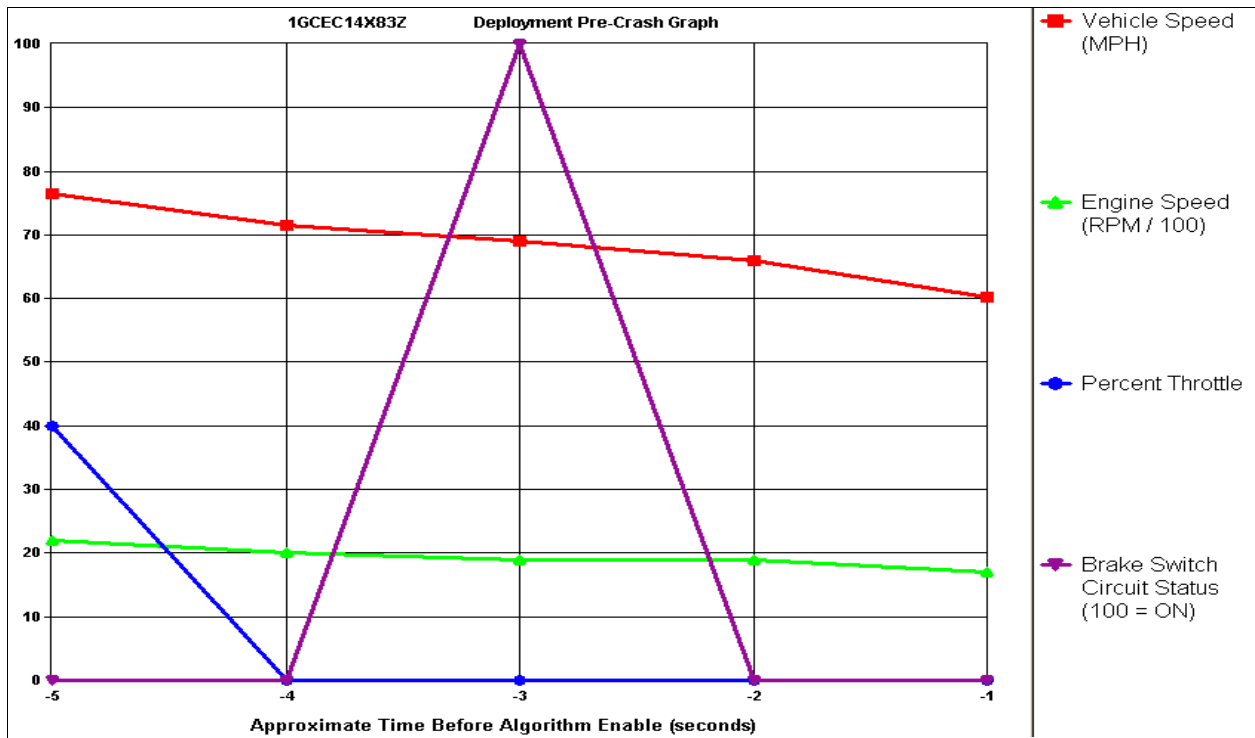


Figure 14: Case vehicle's Deployment Pre-Crash Graph

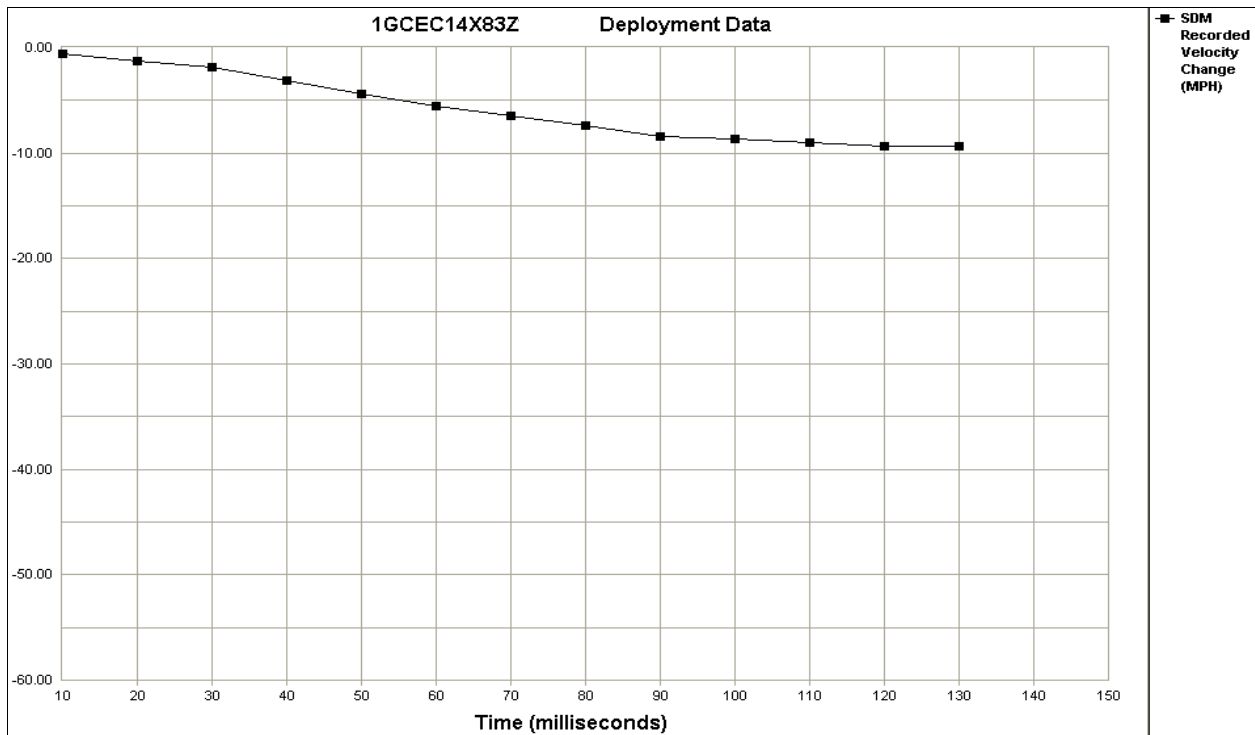


Figure 15: Case vehicle's deployment SDM Recorded Velocity Change graph

1GCEC14X83Z System Status At Non-Deployment																																															
SIR Warning Lamp Status	OFF																																														
Driver's Belt Switch Circuit Status	UNBUCKLED																																														
Ignition Cycles At Non-Deployment	1690																																														
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Event Recording Complete	Yes																																														
Multiple Events Associated With This Record	Yes																																														
One Or More Associated Events Not Recorded	Yes																																														
<table border="1"> <thead> <tr> <th>Time (milliseconds)</th> <th>10</th> <th>20</th> <th>30</th> <th>40</th> <th>50</th> <th>60</th> <th>70</th> <th>80</th> <th>90</th> <th>100</th> <th>110</th> <th>120</th> <th>130</th> <th>140</th> <th>150</th> </tr> </thead> <tbody> <tr> <td>Recorded Velocity Change (MPH)</td> <td>-0.31</td> <td>-0.53</td> <td>-1.86</td> <td>-2.79</td> <td>-3.72</td> <td>-4.96</td> <td>-5.89</td> <td>-7.13</td> <td>-8.06</td> <td>-8.99</td> <td>-9.92</td> <td>-10.85</td> <td>-11.78</td> <td>-12.71</td> <td>-13.64</td> </tr> </tbody> </table>																Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150	Recorded Velocity Change (MPH)	-0.31	-0.53	-1.86	-2.79	-3.72	-4.96	-5.89	-7.13	-8.06	-8.99	-9.92	-10.85	-11.78	-12.71	-13.64
Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150																																
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<p style="text-align: center;">PRE-CRASH DATA</p> <table border="1"> <thead> <tr> <th>Seconds Before AE</th> <th>Vehicle Speed (MPH)</th> <th>Engine Speed (RPM)</th> <th>Percent Throttle</th> <th>Brake Switch Circuit Status</th> </tr> </thead> <tbody> <tr> <td>-5</td> <td>60</td> <td>1664</td> <td>0</td> <td>OFF</td> </tr> <tr> <td>-4</td> <td>39</td> <td>1216</td> <td>0</td> <td>OFF</td> </tr> <tr> <td>-3</td> <td>42</td> <td>1152</td> <td>0</td> <td>OFF</td> </tr> <tr> <td>-2</td> <td>37</td> <td>1088</td> <td>0</td> <td>OFF</td> </tr> <tr> <td>-1</td> <td>30</td> <td>832</td> <td>0</td> <td>OFF</td> </tr> </tbody> </table>																Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status	-5	60	1664	0	OFF	-4	39	1216	0	OFF	-3	42	1152	0	OFF	-2	37	1088	0	OFF	-1	30	832	0	OFF		
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Figure 16: Case vehicle's System Status at Non-Deployment report

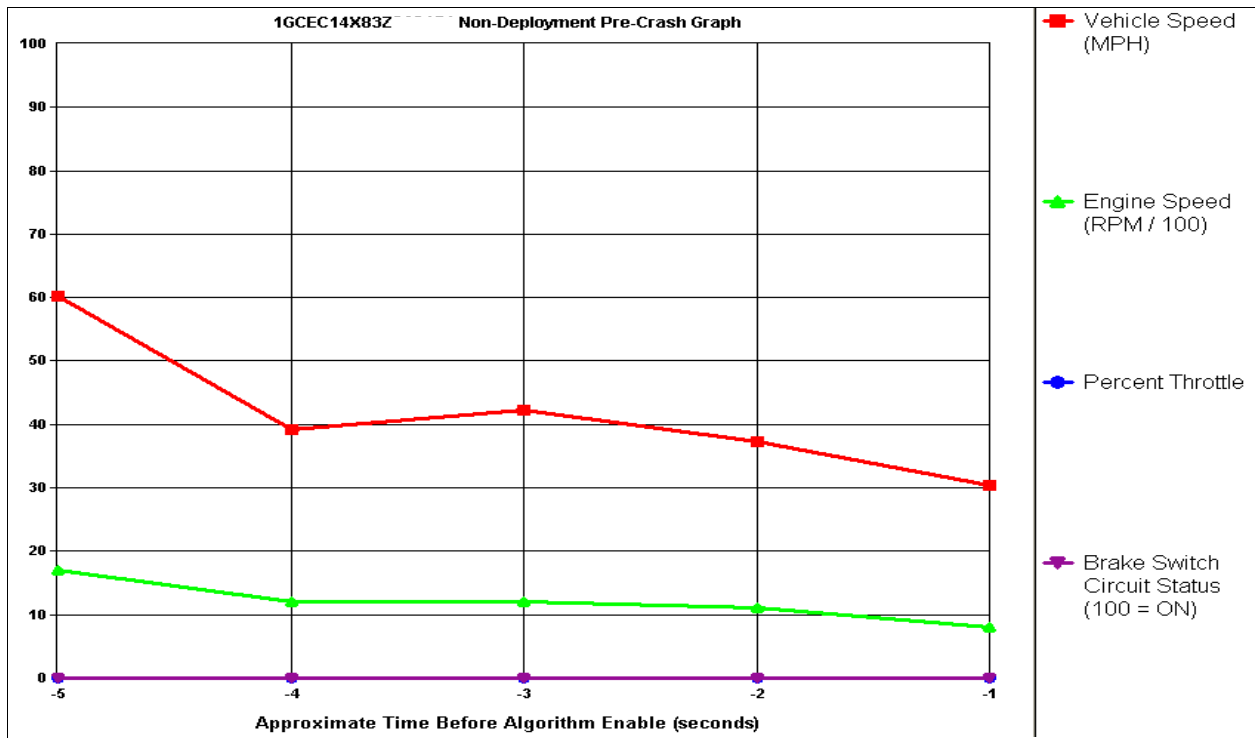


Figure 17: Case vehicle's Non-Deployment Pre-Crash Graph

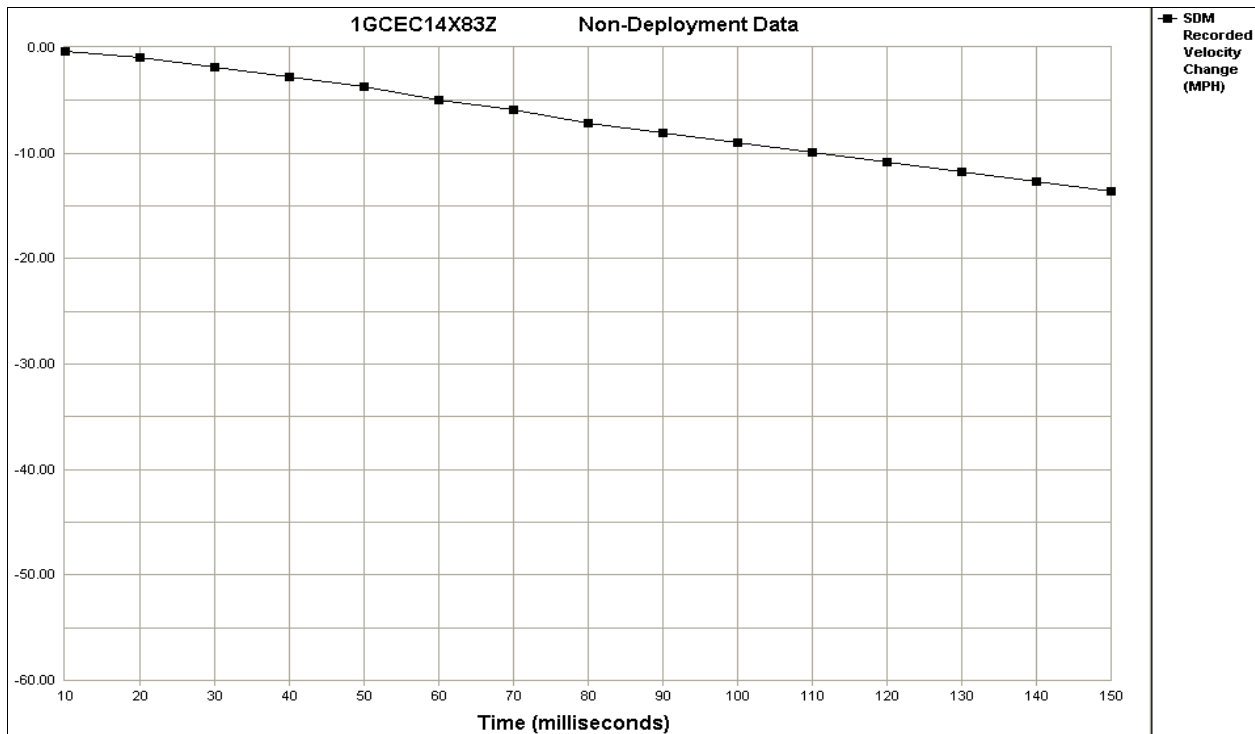
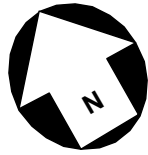


Figure 18: Case vehicle's non-deployment SDM Recorded Velocity Change graph



IN-04-005

Sketch of Events Based on Driver Interview Data and Police Schematic, Not to Scale

Dark with Streetlights, Snowing
Level Concrete and Bituminous Lanes Covered with Snow and Ice
Coefficient of Friction: 0.25
Speed Limit: 97 km.p.h. (60 m.p.h)

Case Vehicle= 2003 Chevrolet Silverado

Motion of Case Vehicle
Prior to Median Barrier
Impact Unknown

