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ON-SITE CHILD SAFETY SEAT INVESTIGATION

CASE NUMBER - IN-06-008
LOCATION - OHIO
VEHICLE - 2001 PONTIAC GRAND AM GT
CRASH DATE - March 2006

Submitted:

November 30, 2006
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Contract Number: DTNH22-01-C-07002

Prepared for:

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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* On-site child safety seat investigation involving a 2001 Pontiac Grand AM GT equipped with redesigned air bags, manual safety belts and a rear-facing infant seat installed in the back right seat position.			
16. *Abstract* This report covers an on-site child safety seat investigation that involved a 2001 Pontiac Grand AM GT (case vehicle), which ran-off-road and impacted a utility pole. This crash is of special interest because the back right passenger [1-year-old, White (non-Hispanic) female was seated in a rear-facing infant seat and sustained fatal injuries as a result of the crash. The case vehicle was traveling northeast in a right curve of a two-lane, undivided state highway. As the case vehicle traversed the curve, it lost traction on the wet roadway. The case vehicle rotated counterclockwise and departed the north side of the roadway with the right side leading. The right side of the case vehicle then impacted a utility pole causing the driver's and front right passenger's air bags to deploy. The impact displaced the utility pole in the ground tilting it to the northeast and fracturing it at the base. The case vehicle rotated clockwise off the utility pole and came to rest heading southeast in the driveway of a farm house. The case vehicle's back right passenger was not restrained in her rear-facing infant seat. The infant impacted her head on the intruded right "B"-pillar during the crash and sustained fatal injury.			
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TABLE OF CONTENTS

IN-06-008

This on-site investigation was brought to NHTSA's attention on May 18, 2006 by an Ohio newspaper article. This crash involved a 2001 Pontiac Grand Am GT (case vehicle) that ran-off-road and impacted a utility pole. The crash occurred in May, 2006 at 2:09 p.m., in Ohio and was investigated by the Ohio Highway Patrol. This crash is of special interest because the back right passenger [1-year-old, White (non-Hispanic) female was seated in a rear-facing infant seat and sustained fatal injuries as a result of the crash. This contractor inspected the case vehicle, downloaded the EDR and interviewed the case vehicle's driver on May 23, 2006. This contractor inspected the scene on May 24, 2006. This report is based on the police crash report, scene and vehicle inspections, an interview with the case vehicle's driver, driver's and back right passenger's medical records, occupant kinematic principles, and this contractor's evaluation of the evidence.

SUMMARY

The case vehicle was traveling northeast in a right curve of a two-lane, undivided state highway. As the case vehicle traversed the curve, it lost traction on the wet roadway. The case vehicle rotated counterclockwise and departed the north side of the roadway with the right side leading. The right side of the case vehicle then impacted a utility pole causing the driver's and front right passenger's air bags to deploy. The case vehicle's EDR data indicated that the driver applied the brakes prior to the impact. The impact displaced the utility pole in the ground tilting it to the northeast and fracturing it at the base. The case vehicle rotated clockwise off the utility pole and came to rest heading southeast in the driveway of a farm house. At the time of the crash the light condition was daylight, the atmospheric condition was light rain and the roadway was wet, travel polished bituminous.

The CDC for the case vehicle was determined to be: **02-RPAN-4** (**70** degrees) for the right side impact with the utility pole. The case vehicle's residual maximum crush was measured as 57 centimeters (22.4 inches) occurring at C_3. The WinSMASH reconstruction program could not be used to reconstruct the case vehicle's Delta Vs because the impact involved a utility pole and the pole yielded. However, the case vehicle's EDR recorded the maximum longitudinal Delta-V as -16.82 km.p.h. (-10.45 m.p.h) for this impact. The total and lateral components of Delta-V were calculated respectively as 39.80 km.p.h (24.73 m.p.h) and -36.06 km.p.h. (-22.41 m.p.h). The case vehicle was towed due to damage.

The back right passenger was seated in a rear-facing infant seat that was being used without a base. The infant seat was manufactured by Cosco, a division of the Dorel Juvenile Group Inc., on December 30, 2003 and was identified as model "Arriva", model number 22-002-DAZ. The back right passenger was not restrained in the infant seat. The infant had been placed in the infant seat on top of the buckled harness straps. The infant was provided only partial restraint by the case vehicle's lap belt, which was routed through the infant seat's belt path, positioning the lap belt across the infant's thighs. The infant sustained open, comminuted, complex skull fractures, numerous brain injuries and bilateral lung contusions due to impact with the intruded right B-pillar, a lacerated spleen due to contact with the right side panel rear of the "B"-pillar and multiple contusions.

Crash Environment: The trafficway on which the case vehicle was traveling was a curved, two-lane, undivided, state highway, traversing in a northeasterly and southwesterly direction. There was one travel lane in each direction. The southwestbound travel lane was 3.6 meters (11.8 feet) in width. The northeastbound travel lane was 3.4 meters (11.2 feet) in width. The roadway was bordered by bituminous shoulders. The north shoulder was 0.6 meter (2 feet) in width. The south shoulder was 1 meter (3.3 feet) in width. There was a line of utility poles on each side of the roadway. The speed limit was 89 km.p.h. (55 m.p.h.). There was no regulatory speed limit sign located near the crash site; however, a curve warning sign and 64 km.p.h. (40 m.p.h) speed advisory sign was posted in the curve on the case vehicle's approach. On the case vehicle's approach, the roadway curved right and ascended up an approximate 4% grade with positive left superelevation, then down an approximate 3% grade to a negative 1% grade at the area of roadway departure. At the time of the crash the light condition was daylight, the atmospheric condition was light rain and the roadway was wet, travel polished bituminous with an estimated coefficient of friction of 0.45. The traffic density at the time of the crash was light to moderate, and the site of the crash was rural. See the Crash Diagram at the end of this report.

Pre-Crash: The case vehicle was traveling northeast in a right curve (**Figure 1**). The driver was intending to continue northeastbound. As the case vehicle traversed the curve, it lost traction on the wet roadway and began to rotate clockwise. The EDR data indicated the case vehicle was traveling considerably in excess of the curve's advisory speed. As the vehicle lost traction, the driver most likely steered left and then right in an attempt to regain control of the vehicle. As the case vehicle approached the right side of the roadway, the driver steered left again and the case vehicle began to rotate counterclockwise. The case vehicle rotated counterclockwise, crossed the roadway and departed the north side of the roadway (**Figure 2** below). The crash occurred on the north side of the roadway in the yard of a farm house. The EDR data indicated that the driver applied the brakes prior to the impact.

Figure 1: Approach of case vehicle northeastbound in right curve, arrow shows location of impacted utility pole

Crash: The case vehicle departed the roadway with the right side leading (**Figure 3** below). The right side of the case vehicle (**Figure 4** below) then impacted a utility pole causing the driver's and front right passenger air bags to deploy.

Post-Crash: The impact displaced the utility pole in the ground tilting it to the northeast and fracturing it at the base. The case vehicle rotated clockwise off the utility pole and came to rest in the driveway to the farm house heading southeast (**Figure 5** below).

Figure 2: Approach of case vehicle to roadway departure and impact with utility pole, new utility pole has been installed

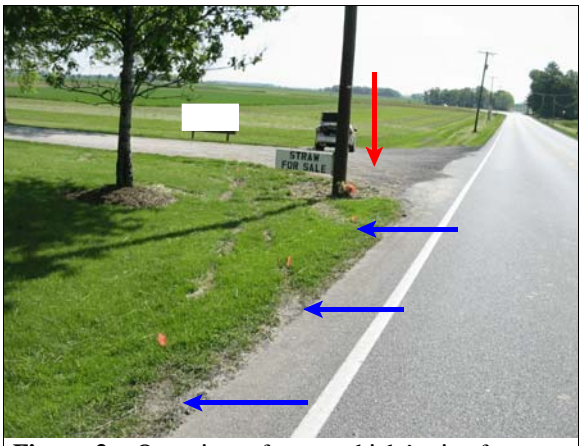


Figure 3: Overview of case vehicle's tire furrows (blue arrows) in grass and location of impacted utility pole, red arrow shows case vehicle's area of final rest

Figure 4: Overview of utility pole impact location on right side of case vehicle

Figure 5: Police on-scene photo showing case vehicle's final rest position and post-impact condition of utility pole

CASE VEHICLE

The 2001 Pontiac Grand Am GT was a front wheel drive, two-door coupe (VIN: 1G2NW12E41M------) equipped with a 3.4L, V6 engine; four speed automatic transmission; four wheel, anti-lock disc brakes and traction control. The front seating row was equipped with bucket seats with integral head restraints, driver and front right passenger redesigned air bags and manual, three-point, lap-and-shoulder safety belt systems. The back seating row was equipped with a bench seat with integral head restraints, three-point, lap-and-shoulder safety belts in the outboard seating positions and a two-point lap belt in the center seat position. In addition, the case vehicle was equipped with an EDR. The case vehicle's wheelbase was 272 centimeters (107.1 inches). The case vehicle's odometer reading at the time of the vehicle inspection was unknown because the case vehicle was equipped with an electronic odometer.

Exterior Damage: The case vehicle's right side impact with the utility pole involved the right front door and right quarter panel (**Figure 6**). The rear portion of the right front door, the front portion of the quarter panel, right "B"-pillar, the sill and right roof side rail were directly contacted and crushed inward. The direct damage began 164 centimeters (64.6 inches) rear of the right front axle and extended 38 centimeters (15 inches) along the right side. Crush measurements were taken at the sill level because the door was open and could not be fully closed. The residual maximum crush was measured as 57 centimeters (22.4 inches) occurring at C_3 (**Figure 7**). The table below shows the case vehicle's right side crush profile.

Units	Event	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	38	57	197	12	23	57	30	35	1	-49	-18
in		15.0	22.4	77.6	4.7	9.1	22.4	11.8	13.8	0.4	-19.3	-7.1

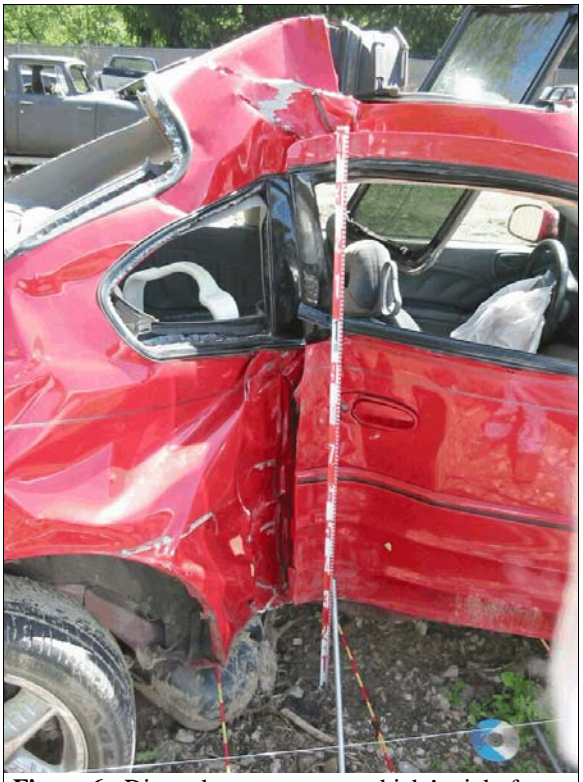


Figure 6: Direct damage to case vehicle's right front door and quarter panel from utility pole impact, increments on tape measure are tenths of meter

Figure 7: Top view of crush to right side of case vehicle due to utility pole impact

The right side wheelbase was reduced 21 centimeters (8.3 inches) while the left side wheelbase was extended 2 centimeters (0.8 inch). Induced damage involved the roof, trunk, right front door, left front door, right quarter panel, left quarter panel and back bumper fascia. In addition, the right front door window, right quarter window, left quarter window and backlite glazing were broken out and the windshield was fractured.

The recommended tire size was P225/50R16, and the case 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	32nd of an inch			
LF	241	35	207	30	5	6	None	No	No
RF	124	18	207	30	3	4	None	No	No
LR	117	17	207	30	4	5	None	No	No
RR	241	35	207	30	3	4	None	No	Yes

Vehicle Interior: Inspection of the case vehicle's interior revealed blood stains on the front right passenger's air bag and some of the driver's hair adhering to the right "A"-pillar, right upper windshield and right front door window frame. In addition, there was a blood stain on the front of the right front seat back. No other evidence of occupant contact to any interior surfaces or components was observed. There was extensive intrusion into the passenger compartment from the right side of the case vehicle. The most severe intrusions involved the back right seat position (**Figure 8**) as follows: the side panel rear of the right "B"-pillar intruded laterally 53 centimeters (20.9 inches), the right "B"-pillar intruded laterally 50 centimeters (19.7 inches), the sill intruded laterally 40 centimeters (15.7 inches) and the right "C"- pillar intruded laterally 31 centimeters (12.2 inches). Lastly, there was no evidence of compression of the energy absorbing steering column or deformation of the steering wheel rim.

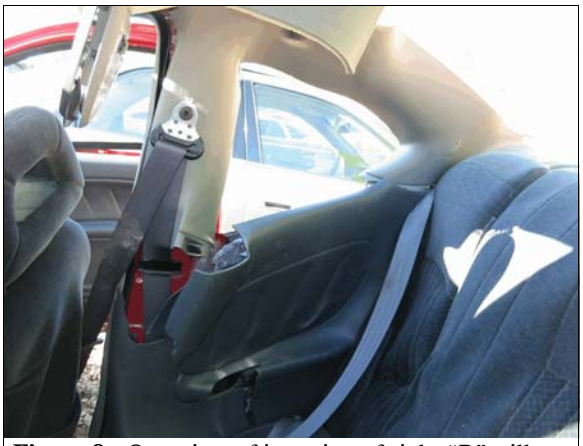


Figure 8: Overview of intrusion of right "B"-pillar, side panel rear of the "B"-pillar and the right "C" pillar into the back right seating position

Damage Classification: Based on the vehicle inspection, the CDC for the case vehicle was determined to be: **02-RPAN-4** (**70** degrees) for the right side impact with the utility pole. The WinSMASH reconstruction program could not be used to reconstruct the case vehicle's Delta Vs because the impact involved a utility pole and the pole yielded. However, the case vehicle's Delta-Vs for this impact were determined using the EDR data. The case vehicle's EDR recorded the maximum longitudinal Delta-V as -16.82 km.p.h. (-10.45 m.p.h) for this impact. Using a direction of principal force angle of 65 degrees (note: CDC direction of principal force is 70 degrees due to rounding rules) based on the approach path of the case vehicle's center of gravity to impact (i.e., the slip angle), the total and lateral components of Delta-V were calculated respectively as 39.80 km.p.h (24.73 m.p.h) and -36.06 km.p.h. (-22.41 m.p.h). The case vehicle was towed due to damage.

The case vehicle was equipped with redesigned driver and front right passenger air bags. Both the driver and front right passenger air bags deployed as a result of the case vehicle's impact with the wooden utility pole.

The case vehicle's driver air bag was located in the steering wheel hub. The air bag module consisted of symmetrical "I"-configuration cover flaps made of thick, pliable vinyl. Each module cover flap was 7 centimeters (2.8 inches) in width at the top and bottom and 14 centimeters (5.5 inches) in height at the vertical tear seam. An inspection of the air bag module cover flaps and the air bag fabric revealed that the cover flaps opened at the designated tear points (**Figure 9**). There was no evidence of damage during the deployment to the air bag or the cover flaps. The driver's air bag was designed without tether straps and had two vent ports, each approximately 3 centimeters (1.2 inches) in diameter, located at approximately the 11 and 1 o'clock positions. The deployed driver's air bag (**Figure 10**) was round with a diameter of approximately 62 centimeters (24.4 inches). The distance between the mid-center of the driver's seat back, as positioned at the time of the vehicle inspection (i.e. forward-most track position), and the front surface of the air bag's fabric at approximate full excursion was approximately 24 centimeters (9.4 inches). An inspection of the driver's air bag fabric revealed no evidence of occupant contact on the front of the air bag. However, a small stain of unknown origin was observed on the right central edge of the air bag and a few possible deployment scuffs were noted at the top of the air bag.

Figure 9: Overview of driver's air bag module cover flaps, each increment on rod is 5 cm (2 in)

Figure 10: Overview of case vehicle driver's air bag

Figure 11: Front right passenger air bag module cover flap

The front right passenger's air bag was located in the middle of the instrument panel (**Figure 11**). The air bag module cover consisted of a single metal cover flap covered with lightly padded vinyl. The cover flap hinged approximately 5 centimeters (2 inches) forward of the flap's back edge. The cover flap's overall

dimensions were 22 centimeters (8.7 inches) in height and 35 centimeters (13.8 inches) in length. An inspection of the air bag module cover flap and the air bag fabric revealed that the cover flap opened at the designated tear points (**Figure 11** above). There was no evidence of damage during the deployment to the cover flap. A few holes from flying glass were noted on the right lower side of the air bag. The front right passenger air bag was designed with two tether straps, each 8 centimeters (3.1 inches) in width. The air bag was not equipped with vent ports. The front right passenger air bag (**Figure 12**) was approximately 67 centimeters (26.4 inches) in height and 48 centimeters (18.9 inches) in width. Inspection of the air bag fabric revealed blood stains, which appeared to be splatter, on the right upper and lower quadrants of the air bag.

Figure 12: Overview of case vehicle's front right passenger's air bag

CRASH DATA RECORDING

The case vehicle's EDR was downloaded by direct connection to the diagnostic link connector. The downloaded data indicated that a non-deployment event and a deployment event were recorded. The non-deployment event was not related to this crash because it was recorded on a different ignition cycle than the deployment event. The EDR reports for the deployment event are presented in **Figures 20-24** at the end of this report.

The EDR system status at deployment report shows that the SIR warning lamp was recorded as off,and the driver's safety belt switch circuit was recorded as unbuckled. In addition, the velocity change graph showed that the maximum recorded longitudinal velocity change was -16.82 km.p.h. (-10.45 m.p.h.) occurring 80 milliseconds after algorithm enable (AE). The data also indicated that the deployment command was issued at approximately 20 milliseconds after AE.

The pre-crash data indicated that five seconds prior to AE, the case vehicle was at 0% throttle traveling at 95 km.p.h. (59 m.p.h.), and the brake switch was recorded as off. At three seconds prior to AE, the brake switch was recorded as on, throttle remains at 0 % and speed was recorded as 90 km.p.h. (56 m.p.h.). The brake switch remains on and percent throttle remains at 0% for the remaining of the pre-crash recording.

CHILD SAFETY SEAT

The back right passenger was seated in a rear-facing infant seat (**Figures 13** and **14** below) that was being used without a base. The infant seat was manufactured by Cosco, a division of the Dorel Juvenile Group Inc., on December 30, 2003 and was identified as model "Arriva", model

number 22-002-DAZ. The infant seat consisted of a one-piece plastic shell with a 2 centimeters (0.8 inch) thick, closed-cell foam pad and a padded cloth cover. A carrying handle was attached to the sides of the infant seat. The infant seat was designed with a three-point harness with a recessed latch fixed to the bottom of the seat. The harness latch plate was attached to the end of the two harness straps. The harness strap was found buckled, and the harness retainer clip positioned at the approximate waist level. There were three sets of harness adjustment slots in the back of the infant seat. The right harness strap was threaded through the bottom slot while the left harness strap was threaded through the top slot. The infant seat was found secured in the case vehicle's back right seat position by the case vehicle's three-point, lap-and-shoulder safety belt (**Figures 15** and **16** below). The lap portion of the safety belt was routed through the belt paths on each side of the infant seat. The shoulder belt was located under the front portion of the infant seat. A police on-scene photograph (**Figure 17** below) show the infant seat in the same condition as observed at the time of the vehicle inspection. Lastly, the infant seat was equipped with a separate LATCH belt that was stored in a mesh pocket in the infant seat cover.

Figure 13: Front of back right passenger's rear-facing infant seat

Figure 14: Overview of left side of infant seat

Inspection of the infant seat revealed that the top portion of the seat was bent to the right (**Figure 18** below) due to the intrusion of the case vehicle's right "B"-pillar and side panel rear of the "B"-pillar. The displacement of the infant seat due to the intrusion appeared to have caused the seat to load against the case vehicle's lap belt, which caused a mark in the plastic on each side of the infant seat below the belt path. The deformation of the infant seat also jammed the carry handle. No other damage on load marks were noted to the infant seat.

There were warning and instruction labels affixed to both sides of the infant seat in English. The manufacturer's warning label giving the infant seat's weight , height and age limitations indicated to use the infant seat only in a rear-facing position with children who weigh 10 kilograms (22 pounds) or less, whose height is between 48-74 centimeters (19-29 inches) and who are under

1 year of age. Illustrations were also presented on the label showing proper installation using a vehicle's lap belt, lap-and-shoulder belt and the LATCH belt provided with the infant seat.

Figure 15: Overview of back right passenger's rear-facing infant seat as found in the case vehicle

Figure 18: Front view of infant seat showing bending of the seat due to loading by the case vehicle's intruding right "B"-pillar and side surface rear of the "B"-pillar

Figure 16: Top view of back right passenger's infant seat showing extent of intrusion of right "B"pillar and side panel rear of "B"-pillar.

Figure 17: Police on-scene photo showing post-crash condition of back right passenger's infant seat

Immediately prior to the crash, the case vehicle's back right passenger [1-year-old, White (non-Hispanic) female, 76 centimeters and 11 kilograms (30 inches, 24 pounds)] was seated in a reclined position in her rear-facing infant seat. Based on the case vehicle inspection, inspection of the infant seat and the police on-scene photographs, the infant seat was secured only by the lap portion of the case vehicle's three-point, lap-and-shoulder safety belt. The lap belt was routed through the infant seat's belt paths.

Based on information provided by rescue personnel and reported on the police crash report, the back right passenger was not restrained in her infant seat. The back right passenger had been placed in the infant seat on top of the buckled harness straps. She was provided only partial restraint by the case vehicle's lap belt, which was securing the infant seat. The routing of the lap belt through the infant seat's belt paths positioned it across the infant's thighs.

Just prior to the impact with the utility pole, the case vehicle was in a counterclockwise rotation and had departed the north side of the roadway with the right side leading. As a result, the back right passenger most likely moved against the left side of her rear-facing infant seat. The case vehicle's impact with the utility pole caused the back right passenger to continue to the right and forward opposite the case vehicle's 70 degree direction of principal force as the case vehicle decelerated and the right "B"-pillar and right side panel rear of the "B"-pillar intruded into her occupant space. Her head most likely impacted the left side of the infant seat and as she came out of her infant seat, her head and upper chest impacted the intruding "B"-pillar causing open, comminuted, complex skull fractures, numerous brain injuries and bilateral lung contusions. The back right passenger's lower torso also impacted the right side panel rear of the "B"-pillar causing a spleen laceration with hemoperitoneum. The back right passenger came completely out of her infant seat as the case vehicle rotated clockwise off the utility pole to final rest. She was found by rescue personnel laying across the top portion of the infant seat. Rescue personnel removed her from the case vehicle through the broken backlite.

CASE VEHICLE BACK RIGHT PASSENGER INJURIES

The back right passenger sustained a police reported "A" (incapacitating) injury and was transported to a local hospital. She was subsequently transported by "life flight" to a childrens' hospital where she died of her injuries. The table below shows the back right passenger's injuries and injury mechanisms.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury with loss of consciousness, vomiting, initially with unequal pupils–later becoming fixed and dilated, hypoxic[1], flaccid, unresponsive to painful stimuli, no gag or cough reflex, GCS =3	critical 160824.5,0	"B"-pillar, right	Certain	Hospitalization records
2	Brain swelling, severe, with global malacia of brain and cervical spinal cord; effaced cerebral gyri; near complete obliteration of ventricles; obliteration of cisterns; brain parenchyma extruding through multiple open skull fractures	critical 140666.5,9	"B"-pillar, right	Certain	Autopsy
3	Hemorrhage, subdural, approximately 25 cc, diffuse, in supra and infratentorial areas	severe 140652.4,9	"B"-pillar, right	Certain	Autopsy
4 5	Infarction[1] bilateral cerebral hemispheres, not further specified	serious 140676.3,1 140676.3,2	"B"-pillar, right	Certain	Hospitalization records
6	Hemorrhage, small, within occipital horn of left lateral ventricle	severe 140678.4,2	"B"-pillar, right	Certain	Hospitalization records
7 8	Ischemia[1] both hemispheres as a result of trauma	serious 140680.3,1 140680.3,2	"B"-pillar, right	Certain	Hospitalization records
9	Hemorrhage, subarachnoid, diffuse, not further specified	serious 140684.3,9	"B"-pillar, right	Certain	Autopsy
10	Contusions, multiple, of brain including frontal and temporal lobes and basal ganglia	serious 140620.3,3	"B"-pillar, right	Certain	Autopsy
11	Contusions, multiple, cerebellum, not further specified	serious 140402.3,6	"B"-pillar, right	Certain	Autopsy

[1] The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
atonic (a-ton/ik): lacking normal tone or strength; pertaining to or characterized by atony.
flaccid (flak/sid; flas/id): 1. weak or soft. 2. *atonic*.
hypoxia (hi-pok/se-a): reduction of oxygen supply to tissue below physiological levels despite adequate perfusion of the tissue by blood. Compare with ***anoxia***.
hypoxic (hi-pok/sik): pertaining to or characterized by hypoxia.
infarct (in/fahrkt): an area of coagulation necrosis in a tissue due to local ischemia resulting from obstruction of circulation to the area, most commonly by a thrombus or embolus.
infarction (in-fahrk/shen): 1. the formation of an infarct. 2. an infarct.
ischemia (is-ke/me-a): deficiency of blood in a part, usually due to functional constriction or actual obstruction of a blood vessel.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
12	Contusions bilateral lungs, left greater than right	severe 441410.4,3	"B"-pillar, right	Certain	Hospitalization records
13	Lacerations, multiple, scattered, upper aspect of spleen with devascularization anterior one-third superior spleen–grade III-IV, with hemoperitoneum left upper quadrant[2]	serious 544224.3,2	Right side interior surface rearward of right "B"-pillar	Probable	Autopsy
14 15 16 17	Fractures, open, comminuted, complex, of posterior occipital skull; fracture anterior skull; fracture left and right temporal and parietal bones as well as posterior parietal bone; with diastasis	severe 150406.4,6 150402.2,5 150402.2,1 150402.2,2	"B"-pillar, right	Certain	Autopsy
18	Fracture, linear, non-displaced, 8 cm (3.1 in) through left and right posterior cranial fossae	serious 150200.3,8	"B"-pillar, right	Certain	Autopsy
19	Contusion {ecchymosis}, severe, diffuse scalp, not further specified	minor 190402.1,0	"B"-pillar, right	Certain	Autopsy
20	Contusion {hematoma} posterior scalp with palpable bone fragments underneath	minor 190402.1,6	"B"-pillar, right	Certain	Hospitalization records
21	Contusion {ecchymosis} forehead, not further specified	minor 290402.1,7	"B"-pillar, right	Certain	Autopsy
22	Contusion {ecchymosis} nasal bridge	minor 290402.1,4	"B"-pillar, right	Certain	Autopsy
23 24	Contusion {ecchymosis} periorbital, not further specified	minor 297402.1,1 297402.1,2	"B"-pillar, right	Certain	Autopsy
25	Contusion, midline, back, not further specified	minor 690402.1,4	Child safety seat	Possible	Autopsy

[2] Complications included hypovolemic shock and shock bowel syndrome with devascularization bowel loops.
The following terms are defined in DORLAND'S ILLUSTRATED MEDICAL DICTIONARY as follows:
devascularization (de-vasku-lr--za'shn): interruption of the circulation of blood to a part caused by obstruction or destruction of the blood vessels supplying it. See also ischemia.
shock (shok): 1. a sudden disturbance of mental equilibrium. 2. a condition of profound hemodynamic and metabolic disturbance characterized by failure of the circulatory system to maintain adequate perfusion of vital organs. It may result from inadequate blood volume (hypovolemic shock); inadequate cardiac function (cardiogenic shock); or inadequate vasomotor tone (neurogenic shock, septic shock).

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
26	Contusion x 2 anterior right lower extremity, not further specified	minor 890402.1,1	Lap portion of safety belt system	Possible	Autopsy
27	Contusion anterior left lower extremity, not further specified	minor 890402.1,2	Lap portion of safety belt system	Possible	Autopsy

CASE VEHICLE DRIVER KINEMATICS

Immediately prior to the crash, the case vehicle's driver [24-year-old, White (non-Hispanic) female, 150 centimeters and 59 kilograms (59 inches, 130 pounds)] was seated in an upright driving position. She most likely had both hands on the steering wheel and her right foot on the brake. Her seat track was adjusted to its forward-most position, the seat back was slightly reclined and the tilt steering column was adjusted to its full down position.

Based on the vehicle inspection, the driver was not restrained by her manual, three-point, lap-and-shoulder safety belt system. Inspection of the driver's safety belt assembly showed no evidence of loading. In addition, occupant contact evidence from the driver was found on the upper right windshield, right "A"-pillar and right front door window frame. The driver would not have contacted these components during the crash had she been restrained.

Figure 17: Overview of driver's head impact to windshield and right "A"-pillar, yellow tape shows hair adhering to windshield and contact mark to right "A"-pillar

Just prior to the impact with the utility pole, the case vehicle was in a counterclockwise rotation and had departed the north side of the roadway with the right side leading. As a result, the driver was most likely leaning to the right just prior to the impact. The EDR data indicated she was also applying the brakes. The case vehicle's right side impact with the utility pole caused the case vehicle's driver to move to the right and forward along a path opposite the case vehicle's 70 degree direction of principal force as the case vehicle decelerated. She was thrown from her seat position, and her right thigh most likely impacted the floor-mounted gear shift lever and her lower legs most likely contacted the center console. Her upper body also most likely contacted the deployed front right air bag. She was most likely positioned face down with her body turned partially to the right as she passed

over the air bag, and the back of her head impacted the windshield (**Figure 19** above) causing a large laceration to the back of her head and a nonanatomic brain injury. The right side of the driver's head also impacted the right "A"-pillar causing a large contusion to the right side of her head. The driver rebounded off these components and as the case vehicle rotated clockwise her head impacted the right front door window frame leaving a deposit of hair in the window frame and she was partially ejected out of the right front window, which had been broken out due to the impact. The driver came to rest with the upper part of her body hanging out of the right front window, where she was found by emergency medical personnel.

CASE VEHICLE DRIVER INJURIES

The police crash report indicated that the driver sustained an "A" (incapacitating) injury. The driver was transported by ambulance to a local hospital. She was treated there and then transferred to another hospital where she was admitted for treatment of her injuries. The driver indicated she was hospitalized for 6 days. The driver also indicated she had received at least one follow-up visit for medical treatment since the crash. No further injuries were diagnosed at the time. The driver had missed in excess of one week of work at the time of her interview. The table below shows the case vehicle driver's injuries and injury mechanisms. The table reflects only interview reported injuries and an injury reported from the initial treatment facility. The admitting hospital refused to honor this contractor's request for access to the driver's medical records.

Injury Number	Injury Description (including Aspect)	NASS Injury Code & AIS 90	Injury Source (Mechanism)	Source Confidence	Source of Injury Data
1	Nonanatomic brain injury, combative, no purposeful movement, GCS = 9	serious 160602.2,0	Front right windshield's glazing	Certain	Emergency room records
2	Strain, acute cervical, more severe on left side of neck/ shoulder	minor 640278.1,6	Front right windshield's glazing {indirect injury}	Certain	Interviewee (same person)
3	Contusion right side of head near temple region	minor 190402.1,1	"A"-pillar, right	Probable	Interviewee (same person)
4	Laceration {cut}, with twelve or more staples, on vertex of scalp, near back of head	minor 190600.1,6	Front right windshield's glazing	Certain	Interviewee (same person)
5	Contusions, random, on back, not further specified	minor 690402.1,9	Right front window sill	Probable	Interviewee (same person)
6	Contusions, random, on legs, not further specified	minor 890402.1,3	Floor, center console	Probable	Interviewee (same person)
7	Contusions, random, about body, not further specified	minor 990400.1,9	Unknown contact mechanism	Unknown	Interviewee (same person)

CDR File Information

Vehicle Identification Number	1G2NW12E41M******
Investigator	
Case Number	
Investigation Date	
Crash Date	
Filename	IN06008.CDR
Saved on	Tuesday, May 23 2006 at 02:43:34 PM
Collected with CDR version	Crash Data Retrieval Tool 2.800
Collecting program verification number	9238B95E
Reported with CDR version	Crash Data Retrieval Tool 2.800
Reporting program verification number	9238B95E
Interface used to collected data	Block number: 00 Interface version: 4A Date: 11-08-05 Checksum: 7500
Event(s) recovered	Deployment Non-Deployment

SDM Data Limitations

SDM Recorded Crash Events:
There are two types of SDM recorded crash events. The first is the Non-Deployment Event. A Non-Deployment Event is an event severe enough to "wake up" the sensing algorithm but not severe enough to deploy the air bag(s). It contains Pre-Crash and Crash data. The SDM can store up to one Non-Deployment Event. This event may be overwritten by another Non-Deployment Event. This event will be cleared by the SDM after the ignition has been cycled 250 times.
The second type of SDM recorded crash event is the Deployment Event. It also contains Pre-Crash and Crash data. The SDM can store up to two different Deployment Events, if they occur within five seconds of one another. Deployment Events cannot be overwritten or cleared from the SDM. Once the SDM has deployed the air bag, the SDM must be replaced.
The data in the Non-Deployment Event file will be locked after a Deployment Event, if the Non-Deployment Event occurred within 5 seconds before the Deployment Event unless a Deployment Level Event occurs within 5 seconds after the Deployment Event, and then the Deployment Level Event will overwrite the Non-Deployment Event file.

SDM Data Limitations:
-SDM Adjusted Algorithm Forward Velocity Change:
Once the crash data is downloaded, the CDR tool mathematically adjusts the recorded algorithm forward velocity data to generate an adjusted algorithm forward velocity change that may more closely approximate the forward velocity change the sensing system experienced during the recorded portion of the event. The adjustment takes place within the downloading tool and does not affect the crash data, which remains stored in the SDM. The SDM Adjusted Algorithm Forward Velocity Change may not closely approximate what the sensing system experienced in all types of events. For example, if a crash is preceded by other common events, such as rough road, struck objects, or off-road travel, the SDM Adjusted Algorithm Forward Velocity Change may be less than and some times significantly less than the actual forward velocity change the sensing system experienced. This data should be examined in conjunction with other available physical evidence from the vehicle and scene when assessing occupant or vehicle forward velocity change. For Deployment Events and Deployment Level Events, the SDM will record 100 milliseconds of data after deployment criteria is met and up to 50 milliseconds before deployment criteria is met. The maximum value that can be recorded for SDM Adjusted Algorithm Forward Velocity Change is about 112 MPH.
-SDM Recorded Vehicle Speed accuracy can be affected if the vehicle has had the tire size or the final drive axle ratio changed from the factory build specifications.
-Brake Switch Circuit Status indicates the status of the brake switch circuit.
-Some of the Pre-Crash data may be recorded after Algorithm Enable (AE). This may happen in situations involving relatively "soft" crash pulses or those that take place over a relatively longer period of time. If this occurs, it may affect the reported pre-crash data values, but does not affect other data such as SDM Adjusted Algorithm Forward Velocity Change.
-Pre-Crash Electronic Data Validity Check Status indicates "Data Invalid" if the SDM receive an invalid message from the module sending the pre-crash data.
-Driver's Belt Switch Circuit Status indicates the status of the driver's seat belt switch circuit. If the vehicle's electrical system is compromised during a crash, the state of the Driver's Belt Switch Circuit may be reported other than the actual state.
-Passenger Front Air Bag Suppression Switch Circuit Status indicates the status of the suppression switch circuit.
-The Time Between Events is displayed in seconds. If the time between the two events is greater than five seconds,

Figure 20: Case vehicle's CDR File Information and SDM Data Limitations

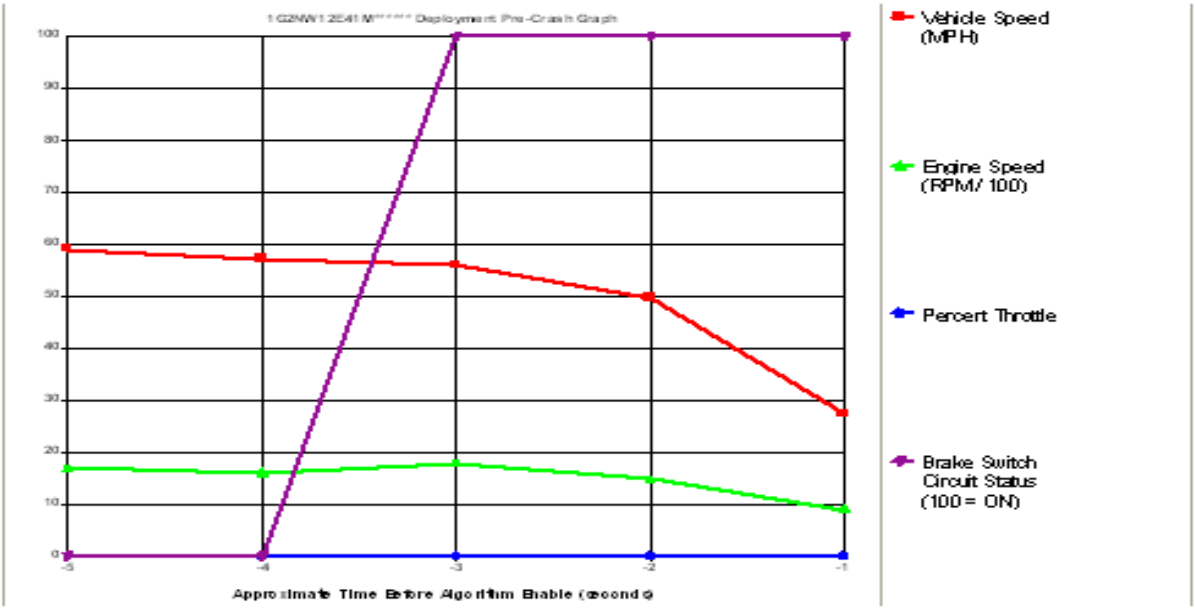
"N/A" is displayed in place of the time.
-If power to the SDM is lost during a crash event, all or part of the crash record may not be recorded.
-If the vehicle is a 2000 - 2002 Chevrolet Cavalier Z24 or a Pontiac Sunfire GT, with a manual transmission (RPO MM5) and a 2.4L engine (RPO LD9), the Brake Switch Circuit Status data will be reported in the opposite state than what actually occurred, e.g. an actual brake switch status of "ON" will be reported as "OFF".

SDM Data Source:
All SDM recorded data is measured, calculated, and stored internally, except for the following:
-Vehicle Speed, Engine Speed, and Percent Throttle data are transmitted once a second by the Powertrain Control Module (PCM), via the vehicle's communication network, to the SDM.
-Brake Switch Circuit Status data is transmitted once a second by either the ABS module or the PCM, via the vehicle's communication network, to the SDM.
-The SDM may obtain Belt Switch Circuit Status data a number of different ways, depending on the vehicle architecture. Some switches are wired directly to the SDM, while others may obtain the data from various vehicle control modules, via the vehicle's communication network.
-The Passenger Front Air Bag Suppression Switch Circuit is wired directly to the SDM.

Figure 21: Case vehicle's SDM Data Limitations continued

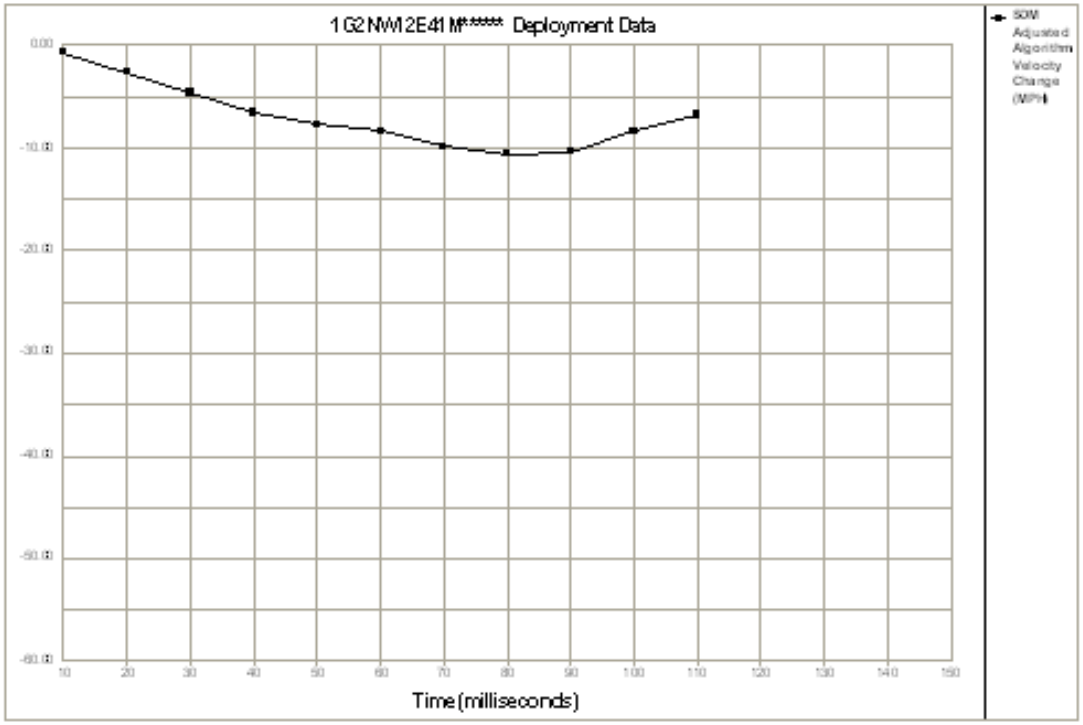
System Status At Deployment

SIR Warning Lamp Status	OFF
Driver's Belt Switch Circuit Status	UNBUCKLED
Passenger Front Air Bag Suppression Switch Circuit Status	Air Bag Not Suppressed
Ignition Cycles At Deployment	7780
Time Between Non-Deployment And Deployment Events (sec)	N/A



Seconds Before AE	Vehicle Speed (MPH)	Engine Speed (RPM)	Percent Throttle	Brake Switch Circuit Status
-5	59	1664	0	OFF
-4	57	1600	0	OFF
-3	56	1792	0	ON
-2	50	1536	0	ON
-1	27	896	0	ON

Figure 22: Case vehicle's System Status at Deployment report and pre-crash data



Time (milliseconds)	10	20	30	40	50	60	70	80	90	100	110	120	130	140	150
Adjusted Algorithm Velocity Change	-0.57	-2.55	-4.52	-6.50	-7.89	-8.25	-9.79	-10.45	-10.23	-8.26	-6.72	N/A	N/A	N/A	N/A

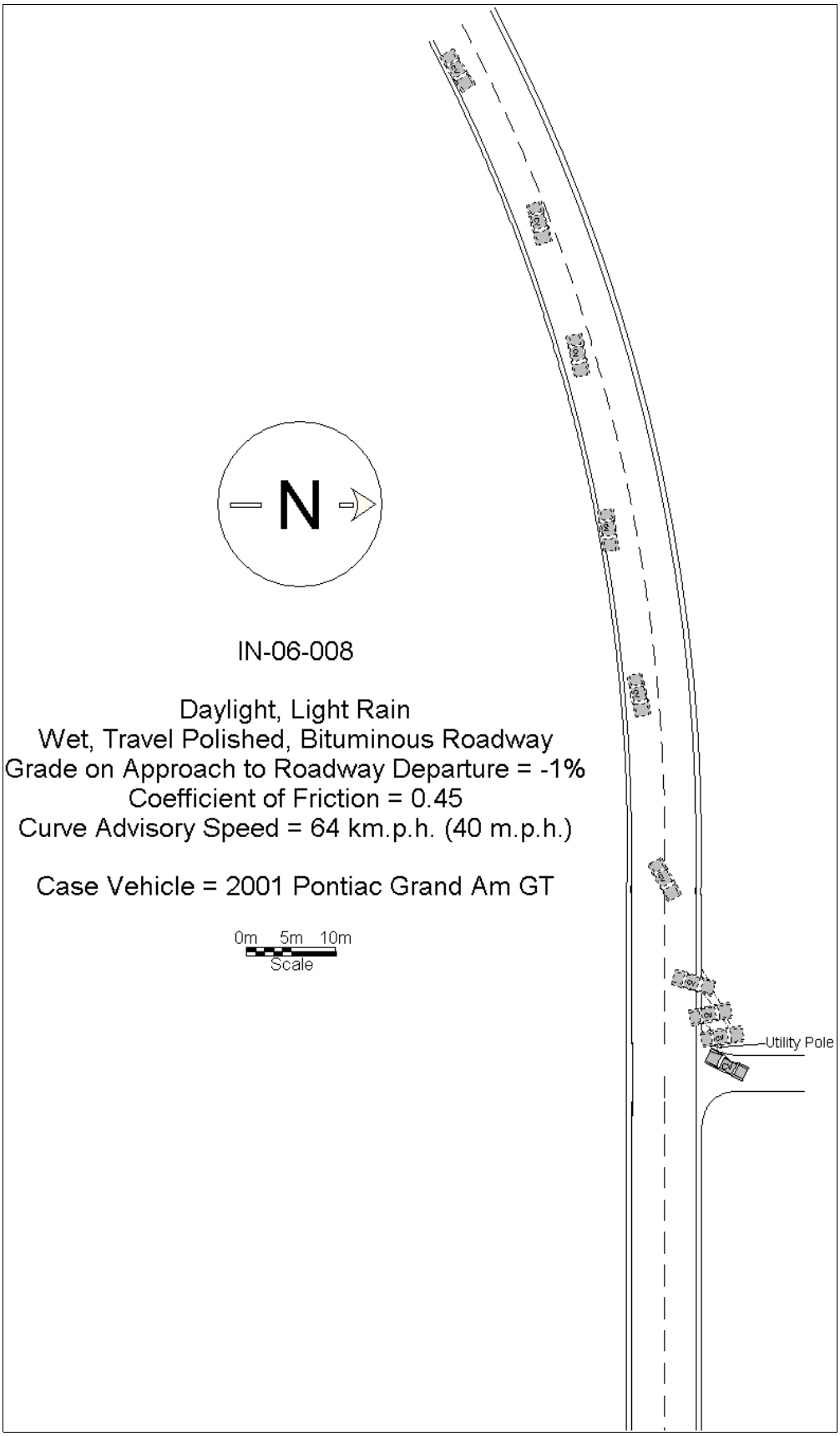
Figure 23: Case vehicle's SDM adjusted algorithm velocity change graph

Hexadecimal Data

This page displays all the data retrieved from the air bag module. It contains data that is not converted by this program.

```
$01  93 23 00 00
$02  92 8C
$03  41 53 30 32 32 31
$04  4B 45 48 45 55 31
$05  00
$06  22 62 77 99
$11  7E 7E 80 FE 84 00
$14  03 04 2C 80
$18  84 83 84 CA FF 00
$1C  FA 32 4E FA FA FA
$1D  FA FA 32 4E FA FA
$1E  FA FA
$1F  FF 02 00 00 00
$20  80 00 00 FF 11 FC
$21  FF FF FF FF FF FF
$22  FF FF FF FF FF FF
$23  FF 00 00 01 00 00
$24  00 00 00 00 00 00
$25  00 00 00 00 FF FF
$26  FF FF 0B 00 00 00
$27  00 00 00 00 00 00
$28  00 00 00 00 00 0A
$29  0A 0A 0A 0A 00 FC
$2A  42 C0 FF FF FF FF
$2B  FF FF FF 00 00 00
$2C  00 00 00 00
$30  80 00 00 FF 80 FE
$31  FF BF FF FF FF FF
$32  FF FF FF FF FF FF
$33  7C 06 03 00 01 05
$34  09 0D 0F 10 13 14
$35  13 0E 0A FF FF FF
$36  FF 0B 3F 02 98 2C
$37  50 5A 5C 5F 00 E0
$38  00 00 00 00 00 00
$39  00 0E 18 1C 19 1A
$3A  00 FC 33 F0 00 00
$3B  00 80 00
$40  FF FF FF FF FF FF
$41  FF FF FF FF FF FF
$42  FF FF FF FF FF FF
$43  FF
```

Figure 24: Case vehicle's hexadecimal data


N
IN-06-008
Daylight, Light Rain
Wet, Travel Polished, Bituminous Roadway
Grade on Approach to Roadway Departure = -1%
Coefficient of Friction = 0.45
Curve Advisory Speed = 64 km.p.h. (40 m.p.h.)
Case Vehicle = 2001 Pontiac Grand Am GT
0m 5m 10m
Scale
Utility Pole